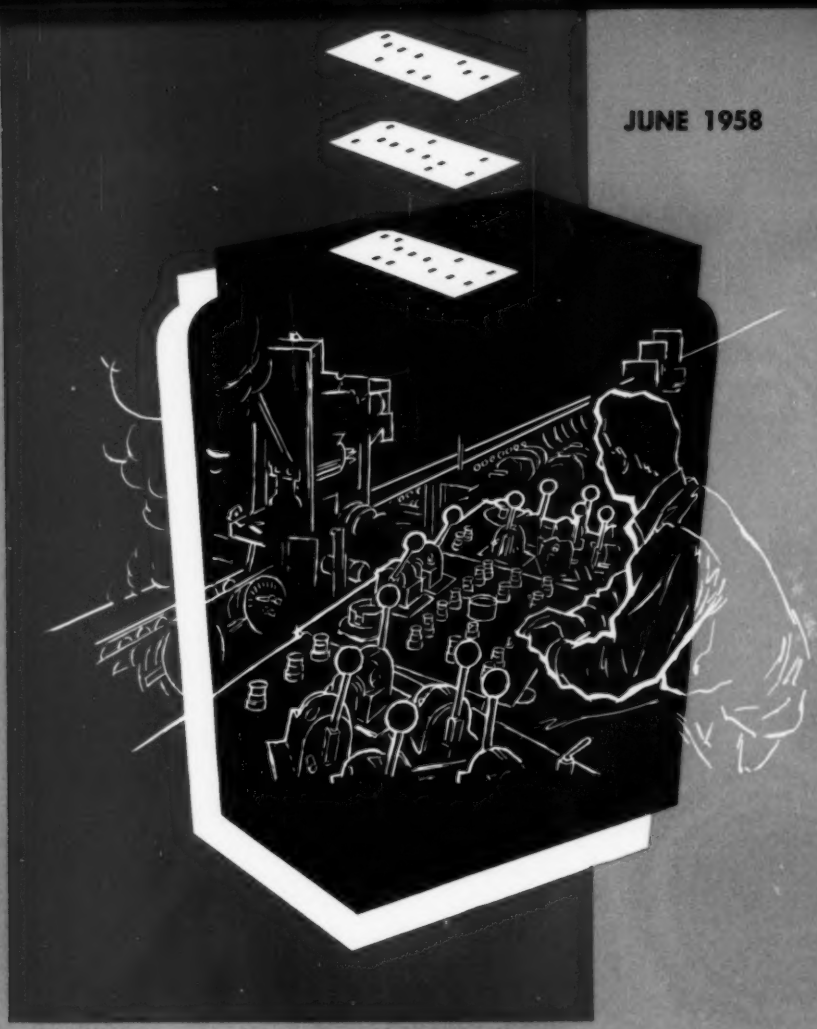
AUTOMATION

JUNE 1958



STRIP MILL USES AUTOMATIC

Programmed Control

The Magazine of Automatic Operations

- Tape Controlled Transfer Machine
- Applying Infrared Analyzers
- Package Conveying System
- Automatic Sequencing Circuits

CONTENTS — PAGE 3

A PENTON PUBLICATION

Scotch About Profits?

Circle 651 on Page 139

Talk to

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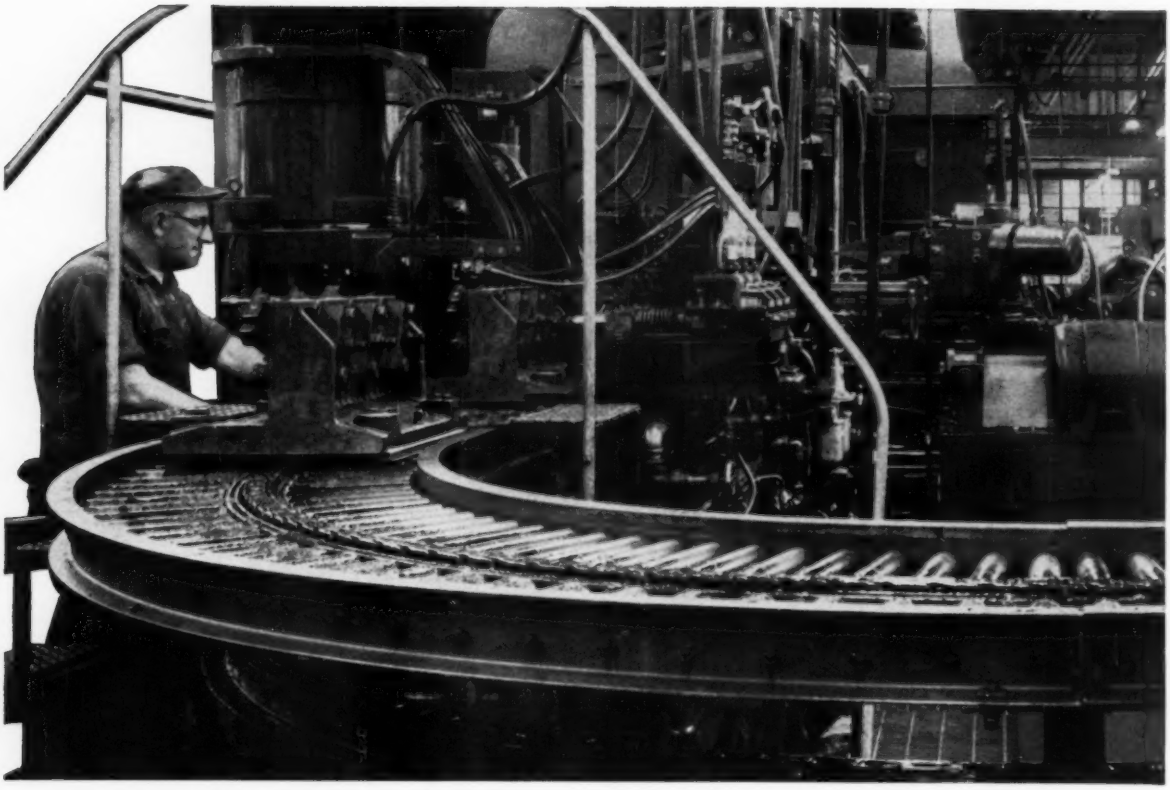
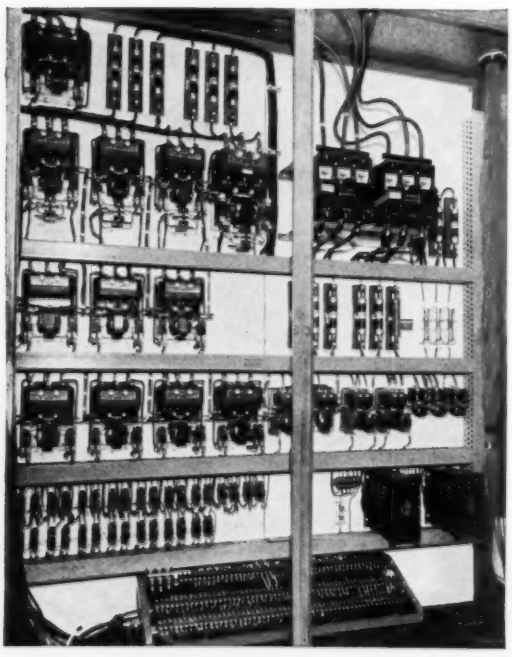
Circle 654 on Page 139



Eaton Manufacturing Company automation line depends on CLARK Type "CY" Starters to minimize costly downtime...



In complex automatic machines used today, dependable electrical controls are essential to continuous operation.

Typical of such machines is this automation line at the Pump Division of Eaton Manufacturing Company in Marshall, Michigan. Designed and built by the Avey Division of The Motch & Merryweather Machinery Co., it performs 132 operations on automatic power steering pump bodies. The control system contains 15 Clark type "CY" starters, in sizes from 1 to 3, designed for dependable, heavy-duty, long-life operation.

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Circle 655 on Page 139

JUNE 1958
Vol. 5—No. 6

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Meetings and Events, 19
Detroit Dateline, 25
Western Roundup, 28
New Equipment, 79
New Components, 101
Abstracts, 121
Books, 130
Editorial Index, 132
Problem Forum, 134
Advertising Index, 135
New Literature, 137
Equipment Index, 139
Readers' Reply Card, 139

Idle Time, 33
EDITORIAL—proper perspective demands that equipment be evaluated as a fundamental part of the over-all productive system.

Tape Controlled Transfer Machine, 34
PROTOTYPE EQUIPMENT—illustrates advantages that follow when transfer machining and numerical control techniques are combined.

Making Gravity Conveyors, 40
AUTOMATION TODAY—needed capacity obtained by improved use of existing facilities following thorough study of plant's operation.

Applying Infrared Analyzers, 46
J. L. GARRISON—control of heat-treat furnace atmosphere results in lower costs, less scrap, and predictable machining properties.

System Straps and Weighs Paper Rolls, 49
PAPER MILL HANDLING—conveyorized installation includes binding, weighing, and turntable units to speed movement of large rolls.

Magnetic Tape Recording, 50
PHILIP A. MOHR—application of recording units to instrumentation problems illustrates industrial utility of magnetic tape.

Integrating Standard Machines, 57
JOHN A. STALEY—gasket retainer production line created from standard equipment linked together by interlocking controls.

Device Feeds Compression Molder, 59
PLASTIC PRODUCTION—operations improved by adaptable automatic unit which cuts off and feeds plastic to molds.

Package Conveying System, 60
JOHN W. STILES—investigation of special handling needs leads to development of unique stacker to handle various carton sizes.

Programmed Control, 64
E. H. BROWNING—reversing roughing mill is equipped with punched card control to obtain efficiency and accuracy in rolling operation.

Production Line Welding, 68
JOHN H. BAUER—redesigned appliance part permits improved operation involving automatically cycling manufacturing equipment.

Automatic Sequencing Circuits, 69
R. HADEKEL—part six—of a series on the synthesis of systems for hydraulic control of automatic machinery.

automation outlook

SHIPPING FUNCTION OFTEN OVERLOOKED

". . . automation has made noteworthy advances in manufacturing areas of progressive plants, but, too often, accumulation and shipping areas have been overlooked in management planning. Examination of existing shipping operations will usually reveal fertile fields for major economies if proper materials handling techniques are adopted. Sometimes off-the-shelf handling equipment will suffice to accomplish this objective, but often new techniques and new machines are required to thoroughly overhaul out-of-date shipping procedures . . ."—*John W. Stiles, president, Island Equipment Corp., see page 60.*

INCREASING PRODUCTIVITY

". . . mass production and technological advancements have given America the highest standard of living in the world, but in order to maintain or advance this high standard of living in the future, American industry must increase its productivity to meet demands of an increasing population and cope with rising production costs. Like many other men in industry, I believe that increased productivity can not be achieved to any great extent without adoption of partial or complete automation. . ."—*H. W. Prentis Jr., chairman of the board, Armstrong Cork Co.*

FLEXIBLE PRODUCTION LINES

". . . despite the decline of capital expansion during 1957, the business climate is favorable for new cost reduction equipment. Industry is now at the brink of a new era of sharp competition and must invest in cost reduction to be able to sell the products of its added capacity. Increased production efficiency through flexible production lines . . . is one of the few immediate answers for cost-conscious management on an industry-wide scale . . ."—*Edward A. Johnson, marketing vice president, Barry Controls Inc.*

CURRENT OPERATING DATA NEEDED

". . . too many companies try to manage on the basis of profit and loss statements, which are merely a recitation of penalty or reward for past performance and ancient history as far as current operations are concerned. The unfortunate result of such decision-making is that the fleeting opportunity for corrective action is lost before it is even recognized. To convert profit-making opportunities into profit dollars, management requires a series of current indices that show exactly how well each phase of the operation is doing in relation to the others . . ."—*Spencer A. Tucker, management consultant, Martin & Tucker.*

INSTRUMENTATION—A NEW FORCE

". . . we have heard a great deal about automation in recent years and its great promise for bringing about major increases in our industrial productivity. Many are inclined to think of automation as something new and modern, but the only essentially modern element in automation is a greatly advanced instrumentation technology which makes it possible to measure automatically, accurately, and reliably essential physical characteristics of goods being produced, processing the results of these measurements with modern computing devices, and then applying the results of the data processing for decision-making and control in the production line. . ."—*Dr. Allen V. Astin, director, National Bureau of Standards.*

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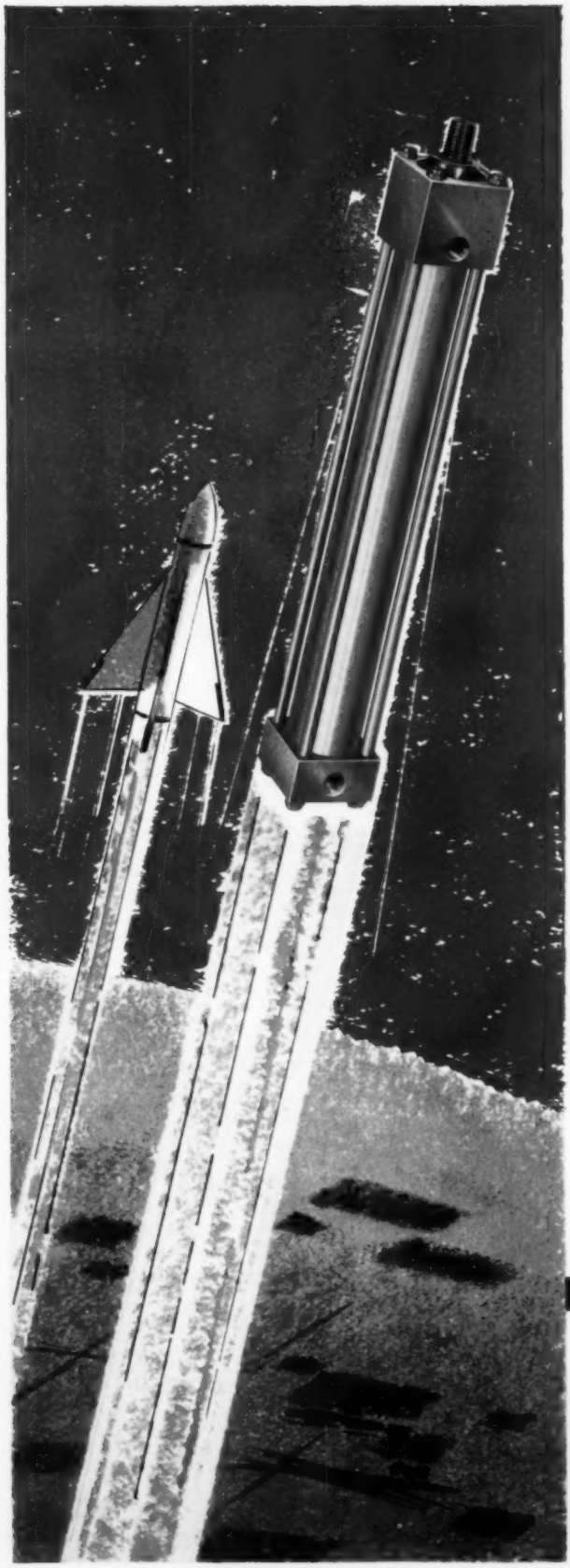

ORTMAN-MILLER Launches Another Star Performer... The O-M Automation

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available in 1½" to 8" bores

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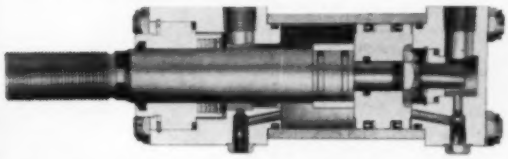

Any resemblance between a guided missile and an O-M AUTOMATION cylinder is purely coincidental. However, each stands as a symbol of progress in its own field.

In the Series RA and RH air and hydraulic cylinders O-M has incorporated many advanced features in an extremely rugged line of cylinders designed to meet automotive industry specifications for Automation cylinders. The advanced design of these cylinders makes them well suited for severe applications in all types of machinery and equipment.

For detailed information, consult your local O-M representative or see our new catalogues No. 107 for Air Cylinders— No. 108 for Hydraulic Cylinders.

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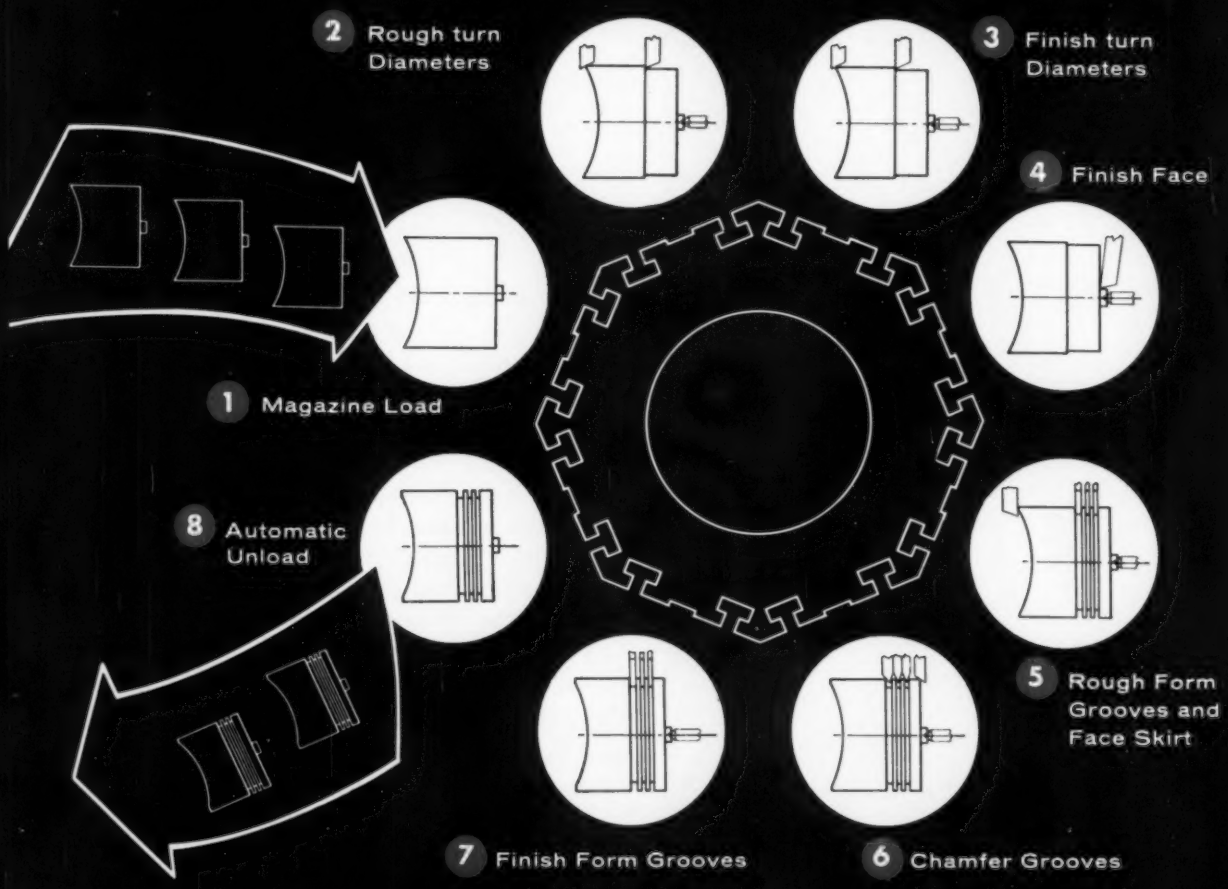
Circle 656 on Page 139

here is

circumferential automation

at work . . .



Here's an example of Circumferential Automation integrated into an automated production line. Castings are conveyed to the magazine which loads the machine. After machining (16 operations in 8 seconds) is completed the piston is automatically unloaded—carried on to assembly.

...Automatic Load—Unload Accessories INTEGRATE

circumferential automation*

and in-line automation

* Each spindle of an Acme-Gridley Automatic is a work station where a number of machining operations can be performed. From the time the work piece is loaded into the spindle it is never let go; indexes from station to station where pre-sequenced operations are carried on without manual attention. Upon completion workpiece is released at the unloading position and is subsequently transferred to the line. Secondary operations are eliminated. This is automation . . . circumferential automation.

Acme-Gridley automatics equipped with magazine loading and unloading devices can easily be integrated into fully automated production and assembly lines. They provide maximum production flexibility and assure day-in, day-out operation with minimum human attention.

Let us show you how circumferential automation can go to work for you.—our representative will be glad to call without obligation.

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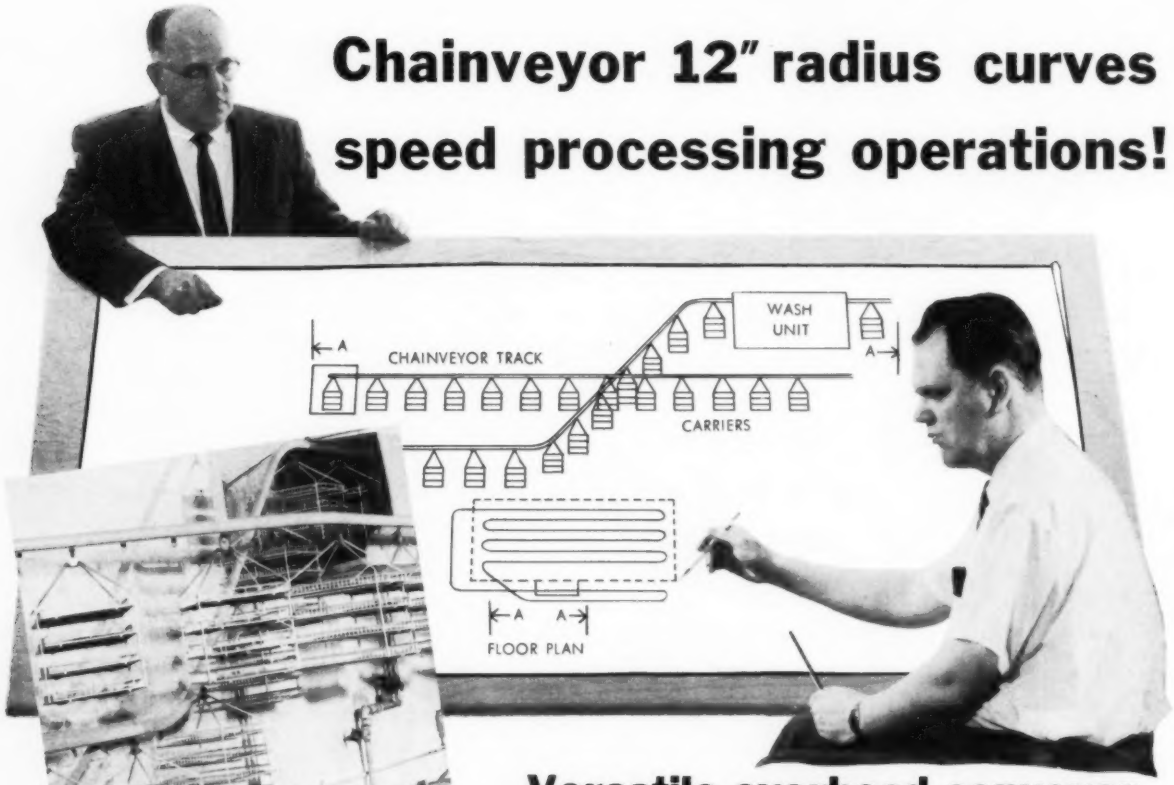
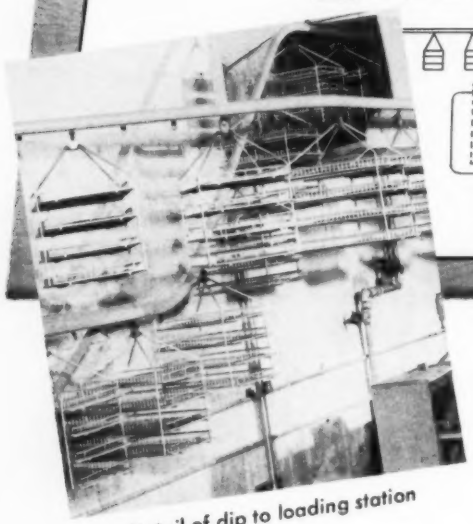
and time to be saved there's an Acme-Gridley to do it.

Circle 657 on Page 139

Chainveyor 12" radius curves speed processing operations!





Detail of dip to loading station

Versatile overhead conveyor puts "waste space" to work!

When this food processor converted from bulk packaging to individual handling and freezing, small separate loads had to be transported continuously through preparation and freezing to packaging.

From the planning board came the answer — a versatile conveyor system that turns, climbs and dips sharply to provide an uninterrupted flow from start to finish. The 440-foot Chainveyor system runs entirely *overhead* – taking advantage of unused ceiling space and freeing floor area for working and storage. Exclusive short radius turns permit four passes through a compact freezing room allowing a full hour of freezing at "20 below"

The conveyor is routed overhead from room to room through small wall openings, and dips to work stations only for loading and unloading. Plant management reports substantial savings in manpower and refrigeration costs, with no maintenance difficulties.

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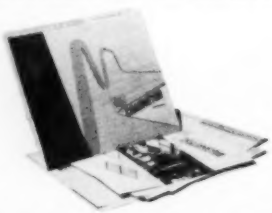

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Explanatory diagram illustrating a typical Chainveyor layout showing component parts.

Plant and conveyor planning grid sheets for preliminary layouts.

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Circle 658 on Page 139

AUTOMATION news

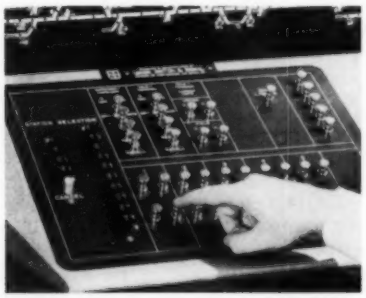
Today's events and developments in the field of automation

Compact Pushbutton Panel Controls Railroad Traffic

CENTRALIZED traffic control of railroads was introduced approximately 30 years ago as a solution to efficiently controlling growing networks of complex track systems. Since that date, there has been a steady trend toward enlarging the territory controlled from each division headquarters. As the amount of territory increased, the size of control consoles increased until they became too spread out for one dispatcher to watch and operate efficiently.

A new centralized control center has been developed by Union Switch & Signal, Div., Westinghouse Air Brake Co. It provides a means of concentrating the control of railroad traffic into a center small enough for one dispatcher to watch and control without shifting his position. The new control center will handle four times the territory and track that were previously controlled in centers of the same physical size.

COMPACT control center developed by Union Switch & Signal, Div., Westinghouse Air Brake Co., handles approximately four times the territory previously controlled by a center of the same physical size. Tiering of track diagrams and consolidations of switch and signal controls into a small panel in front of dispatcher account for the additional territory coverage.



SELECTION and function control panel gives dispatcher fingertip control of railroad division. In addition to actuating switches and signal, the upper rows of pushbuttons control various miscellaneous functions such as snow melters, carrier units, and call signals.

On old type control centers, track diagrams were strung out around the top of the panels with individual switch and signal levers for each controlled function located directly beneath its point on the diagram. The newly designed center has removed all switch and signal controls from the front plate of the track diagram panels and has consolidated them into a compact panel in the center of the desk type console. This has allowed the track diagrams to be miniaturized into standard 3-foot units which can be tiered to conserve space and permit one-man control of large territories.

Key to the operating efficiency of the control center is the small selection and function control panel located directly in front of the dispatcher. This unit gives him fingertip control of any point in his territory. On the left side of the panel (see closeup view), are selector pushbuttons that connect any one of 99 controlled locations with a function actuator panel across the bottom of the unit. Each function panel is equipped with pushbuttons for controlling switch and signal operation at the controlled locations. When the selection and function pushbuttons are actuated, memory relays associated with the given location energize the switch and signal units and, at the same time, light indicator lamps on the track diagrams to show track occupancy, switch position, and red or green signal condition.

The design of the control center permits it to be used with existing

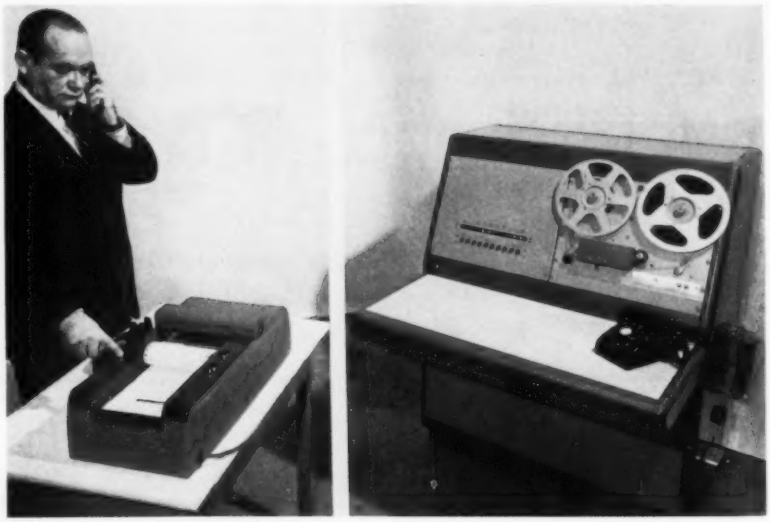
code systems or with direct wire or carrier control. There are no relays housed in the center. The base is designed for mounting of plug connectors which are used to connect the control console and track diagram units with relay racks located in an adjacent equipment room. The modular construction of the base, desk, and track diagrams permit adding or removing modular units to meet changing track conditions.

Future Growth of Control Industry Forecast

CONFIDENCE in the economy has been expressed in statements by various spokesmen in the electrical control field. Their remarks foretell continued growth in this field with little dampening effect by the current economic situation.

In a speech at a Marketing Conference sponsored by the American Management Association during February, **J. H. Jewell,** vice president in charge of marketing at Westinghouse Electric Corp., predicted that automation will grow from a $2 billion business in 1958 to a $5 billion business in 1965. Industry will need "a formidable list" of products: industrial controls, both electric and electronic; instrumentation and inspection devices; motors; nuclear controls; radiation equipment; switchgear; transformers; and turbogenerators. The fact that "American industry is seriously underpowered for the productivity it will require tomorrow" also indicates a growing market for the electrical industry. Westinghouse studies show that 52 per cent of today's plants have low incoming voltage; 85 per cent have inadequate power capacity; and approximately 100 per cent lack adequate transformer capacity for future growth.

Speaking before a General Electric Co. marketing seminar in April, **W. O. Hoverman,** manager of sales for G.E.'s Semiconductor Products Dept., predicted that total industry sales of semiconductors, including transistors and other solid state electronic components, will reach $70 million in 1958 in spite of the current business recession. Last year's sales were $55 million. Hoverman predicted sales of industrial electronic equipment itself at $1.3 billion this year and predicted an increase of at least 40 per cent by 1960.



ELECTRONIC device called Ordomat automatically transmits ordering information via telephone lines from a central office to a warehouse. Michael C. Poylo, assistant to the vice president at Federal Telecommunication Laboratories and inventor of the equipment, presses a button to begin transmission. Information is marked on a paper form with a grease pencil and is translated into audible tones by a photoelectric machine. The information is relayed by telephone lines to a magnetic tape in the warehouse. The data are then automatically transferred from tape to punch cards for processing by business machines.

Traffic Lights Controlled By Radio Tone System

RADIO CONTROL system developed by the Communications and Industrial Electronics Div., Motorola Inc. controls traffic lights by radio transmission of tone signals. The system can control more than 1000 group or intersection selections with up to 16 control function changes per intersection.

The system controls local intersection functions such as dial selection, offset selection, offset synchronization, and other light conditions which the local controller is capable of instituting. Depending on the number of program changes per week required, the central programmer can be a simple clock-type device or a punched card or tape unit. Information from the programmer is translated into tone codes which are then transmitted by radio equipment to FM receivers at each intersection. The local intersection controller then decodes and translates the tones to initiate the desired program.

Constant system synchronization is insured by continuous transmission of a synchronizing signal to all intersection controllers in the system. This signal is independent of and does not interfere with function changes. A central display panel shows the last transmitted program to each intersection and provides manual control of selected functions.

Radioisotopes Save Industry More Than $300 Million Yearly

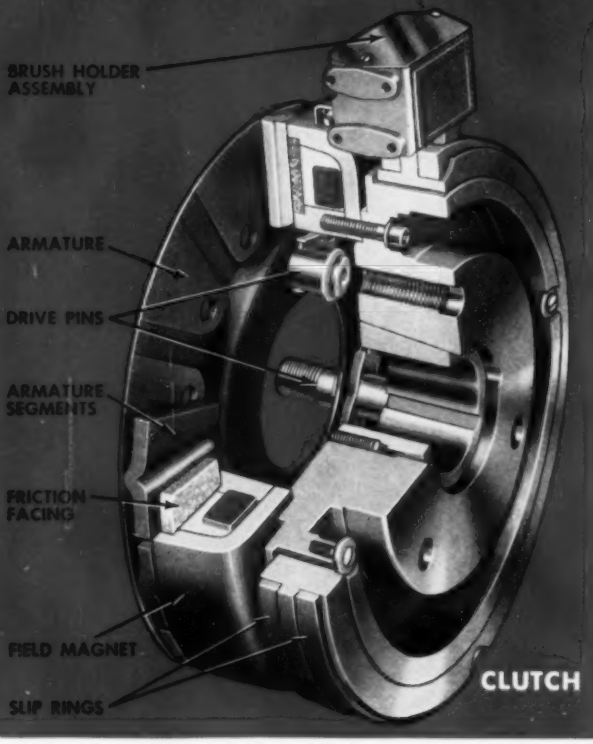
INDUSTRIAL users of radioisotopes have grown from 18 in 1946 to more than 1500 in 1957 according to a two-year study released by the National Industrial Conference Board. In addition, a large number of firms have also obtained radioisotopes from the Atomic Energy Commission when only small quantities were involved. AEC estimates that radioisotope applications are saving American industry more than $300 million each year.

Last year the atomic reactors operated by General Electric Co. at Hanford for the AEC produced ra-

The New EATON Dyna-TorQ

MAGNETIC-FRICTION CLUTCHES, BRAKES, CLUTCH-BRAKES, CLUTCH-COUPLINGS

Are the Accurate, Trouble-Free Means of Controlling Power and Motion in Modern Stop-and-Go Machines

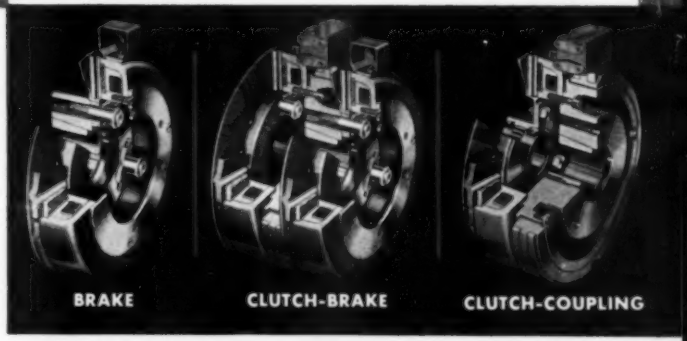


The Eaton Dyna-torQ electro-magnetic friction units include a number of unique design advancements which provide longer life and superior performance with less maintenance. Check the following important advantages:

1. **Extremely Rapid Response in Clutching and Braking**—makes Dyna-torQ units ideally suited to a wide range of manual and automatic cycling applications.
2. **Smooth, Shockless Engagement**—permits rapid operation without backlash or chatter.
3. **Highly Effective Cooling**—maintains lower operating temperatures; permits fast, repetitive actuation.
4. **Self-Adjustment**—automatically maintains proper clearance between armature shoes and field magnet.
5. **Simple, Accurate Control**—manual or automatic; may be had to operate on 110, 220, or 440 volt, 60 cycle, alternating current.
6. **Low Maintenance Costs**—result from unique design features and superior quality of construction, assuring long operating life and minimum down-time.

Eaton Dyna-torQ Clutches and Brakes are electrically operated, disc-type friction units having two basic components: a field magnet and an armature. Torque is transmitted as the magnet pulls the armature into engagement. Because the pull of the magnet is direct without intricate linkage, and the movement of the armature is slight, Dyna-torQ units are capable of extremely rapid response in clutching or braking.

Ask us to tell you how these Dyna-torQ units will fit your equipment.



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Circle 659 on Page 139

dioisotopes equal to about 460 pounds of radium. The significance of this production is striking when compared to the world supply of radium. In 60 years this supply has only grown to about 1500 curies or approximately 3.3 pounds.

Seventy-five per cent of the industrial uses of radioisotopes are for gaging, radiographing (X-raying), tracing, and process control. Gaging is the most common industrial application. Nearly 3500 gages utilizing radioactive material have been licensed by the AEC. Of these, approximately 2000 are in use in the cigarette industry.

Radiocobalt (Co-60) was the most popular isotope produced at Hanford last year. It is used in hospitals to treat cancer and in industry to photograph welds and castings for internal flaws.

Second ranking isotope produced last year was thallium-204. Hanford made 218 curies of it. Chief use in industry is in thickness gages for continuous strip processes. Producers of paper, rubber, plastics, and textiles place a capsule of Tl-204 on one side of a strip and a sensitive beta-ray detection instrument on the other. Any variation in the thickness of the strip produces a change in intensity of rays penetrating the strip. The gage can be connected electrically to the process machinery to automatically adjust the thickness of the strip to desired specifications.

Other radioisotopes produced at Hanford in 1957 were as follows: Silver-110, 38 curies; cesium-134, 86; iron-55, 3; mercury-203, 45; antimony-124, 11; tin-113, 1; tantalum-182, 1; tungsten-185, 2; zinc-65, 2; carbon-14, 46.

Extrusion Process Replaces Costly Machining Operation

COST REDUCING method of making turbine and compressor rotors for jet and gas turbine engines has been developed by the Engineering Research Office, Ford Motor Co. The new method eliminates close-tolerance broaching that formerly was required on blade ends and rotor hub cavities before the parts could be assembled in completed units.

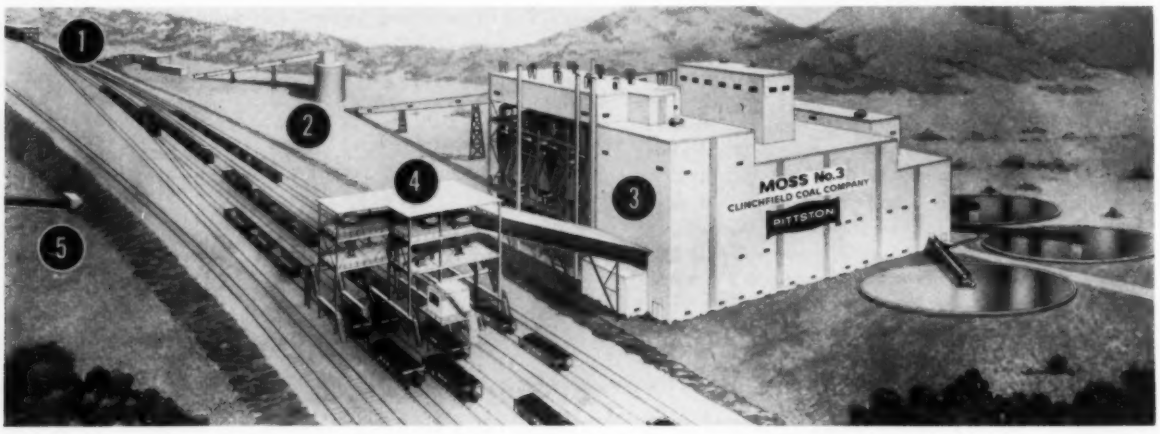
In the new process the hub ends of the rotor blades are used in their unfinished cast or forged shape. The blades are positioned in a rotor configuration between an outside ring and an inner die. The tips of the blades fit into slots in the ring and the blade ends fall into cavities in the inner die. An alloy that melts at approximately 700 F is poured around the blades and between the ring and die.

After the alloy has solidified, the inner die is removed, leaving the blade ends exposed. A hot billet is then inserted in the opening and a heavy forging press extrudes the billet over, under, and around the blade ends to form the rotor hub. After the alloy filler is removed, the parts are lightly machined to remove excess hub metal.

The new method reduces costs by eliminating machining operations on the blade ends and hub cavities. Tolerances on these operations were as small as 0.0005 inch. Wheel units up to 30 inches diameter can be produced with a forging press having 30,000-ton capacity. Turbine wheels already are being produced with the new process by Steel Improvement & Forge Co. in co-operation with Ford's Research Office. This firm is negotiating contracts to produce 6 and 9 inch wheels at less than $100 each plus the cost of the blades.

Handling Show Features Cost Reduction Techniques

EQUIPMENT valued at more than $5 million will be on display at the National Materials Handling Exposition in Cleveland's Public Auditorium on June 9-12. Exhibits will emphasize handling techniques and systems designed to reduce the cost of moving materials and products from receiving lines, through production, and into distribution.



CONSTRUCTION contract for an automated coal preparation plant has been awarded to Link-Belt Co. by Clinchfield Coal Co. The new plant will be located at Clinchfield, Va., and will wash, dry, and screen 1500 tons of run-of-mine coal per hour. Architect's drawing shows the following features of the new plant: 1. Coal is delivered from mine 7 miles away by railroad and emptied from car by rotary dumper. 2. Coal is conveyed to crusher house, from crusher house to surge bin, and from surge bin to processing plant. 3. Plant will use eight Link-Belt tank-type heavy media washers. Four will be used as primary washers to secure high quality metallurgical coal and four will be used as secondary washers to recover steam coal. 4. After drying, coal is conveyed to loading tower for shipment. 5. Turn-over belt conveyor, 2500 feet long, carries refuse from plant to disposal area. To avoid buildup of material on underside of belt, belt is turned over after discharging refuse and returns to plant with top side of belt up. At plant, belt is turned over to its normal position.

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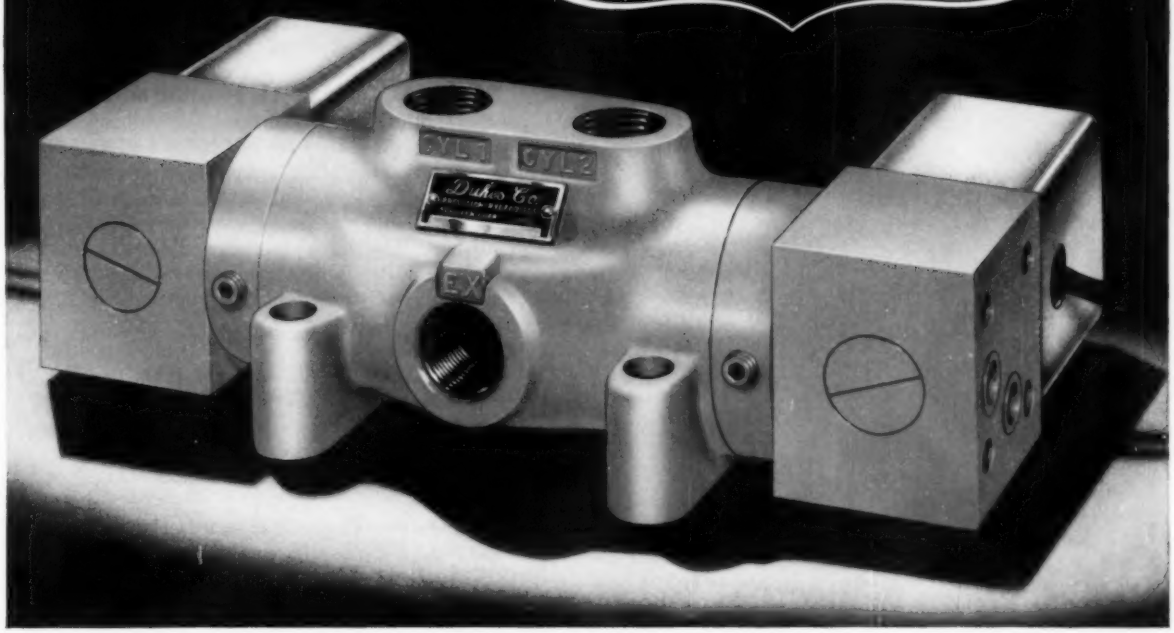
it sets a new standard of comparison . . .

DUKES



UPGRADE your requirements. This new valve will meet them

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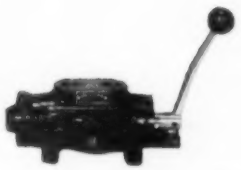

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Circle 660 on Page 139

Concurrently with the show, the American Society of Mechanical Engineers will sponsor a conference on the subject of materials handling. Conference subjects will include design and development of special equipment, scientific management and materials handling, new developments in handling, and handling in the atomic age. Other subjects will consider the effect of automation and the need for different equipment to do specialized jobs.

The exposition is produced by Clapp & Poliak Inc. More than 200 companies showing over 6000 products will be at the show. Railroad sidings outside the auditorium will be used to demonstrate various types of freight car loading and unloading techniques.

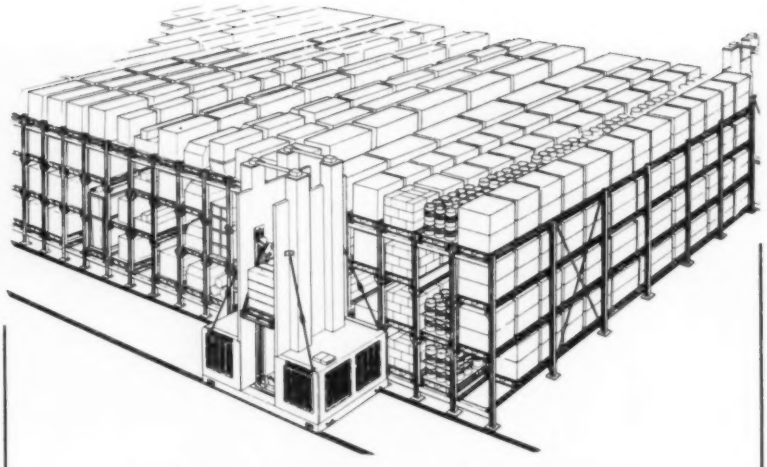
Color Code Standard For Pneumatic Panel Tubing

COLOR CODE for pneumatic panel tubing has been established in a set of standards published by the Instrument Society of America. A survey conducted by ISA revealed that color coding was in wide use, but there was no uniformity in selecting a given color for a given service.

Recommended by ISA for industry wide adoption is the following standard for color coding of pneumatic tubing on instrument panels: Air supply—red, seal—purple, set—black, alarm—green, readout — blue, transmitted — orange, controlled—yellow, and all others —natural.

SPOTLIGHTING PEOPLE

Edward I. Brown appointed director of engineering for Machinery Hydraulics Div., Vickers Inc. . . . **John K. Rudd** named manager of Custom Products Div., **William R. Runo** appointed manager of Standard Products Div., and **Samuel M. Dix** named manager of Resale Products Div. of Richardson Scale Co. . . . **John G. Frischkorn Jr.** appointed sales manager of the Cleveland Tramrail Div., Cleveland Crane & Engineering Co. . . . **E. D. Swenson** named chief engineer of the materials handling section, Baker Per-



Pallet System Doubles Warehouse Capacity

AUTOMATIC warehousing system that can double the effective static volume handled by a conventional warehouse is available from the Automatic Warehousing Branch of Pesco Products Div., Borg-Warner Corp.

The new storage concept, sketched above, is based on storage of goods on special wheeled pallets. Maximum space use and operating economy are achieved when full pallets are picked and shipped as a unit load. The system may be operated initially by fork trucks and converted to automatic operation at a later date.

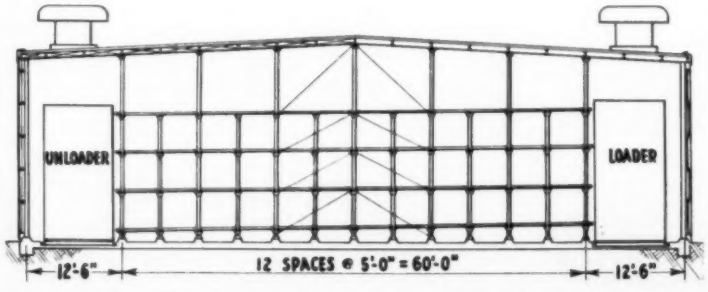
Automatic design saves valuable warehouse space now alloted to aisles, lunch areas, toilets, and heating equipment. Four-cell high system handling 4-foot square pallets will accommodate 12,000 pallets in 50,000 sq ft of floor space. Conventional warehouse holds approximately 6000 pallets in the same floor space.

Automatic warehouse is operated by one man from a central control center. In a typical loading cycle, operator dials the row number and cell height to which pallets are to be delivered. Automatic loader picks up two pallets, advances to the designated cell for the first pallet by electrically counting inches of travel, and centers on the desired row. Loader elevator then automatically raises the pallet to the proper cell.

Hydraulic cylinders lift a load table which automatically advances to load the pallet into the cell. Second pallet can be loaded into the same cell or a different cell in a similar manner.

Operation of the unloader unit on opposite side of cells is identical and reversed from loader unit, sketched below. Cells are sloped toward unload side so that pallets continually feed forward as pallets are removed from cell. Operator can also designate from control center the unloading point of the automatic device.

Return rail system allows mixed goods to be stored in same cell. With this system, unloader removes pallets one at a time and places them on return rails at end of rack. Loader unit on opposite end of rails picks up pallet and returns it to cell. When desired pallet is unloaded, cycle ceases, and pallet is carried to discharge point.



Farval lubrication helps side milling machine work at faster speeds

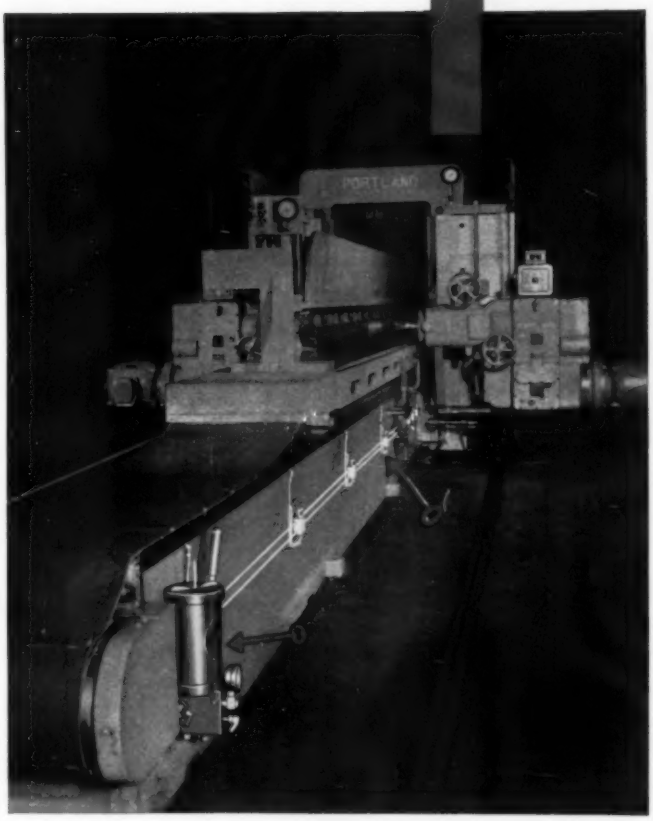
FARVAL—
Studies in Centralized Lubrication
No. 213

● Designed and built by Portland Machine Tool Works, this machine is used for side milling laminated steel plates in a western Pennsylvania steel plant. Employing a climb cut, both milling heads generate extreme downward pressures on the table ways. To protect against these extreme pressures on the ways, a Farval lubrication system was installed.

Result—unusually high speeds in milling are possible and usual, and not an hour of production time has been lost due to faulty lubrication. Periodic operation of the Farval hand pump keeps the ways working perfectly.

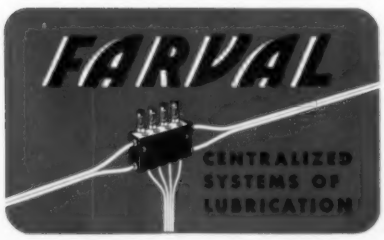
Free Lubrication Survey—Why not find out where Farval can save you time and money? One of our lubrication engineers will be glad to inspect your plant equipment. He will present a written analysis, without obligation, of what Farval can do for you. And for the complete Farval story, write for Bulletin 26-S, The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: Peacock Brothers Limited.



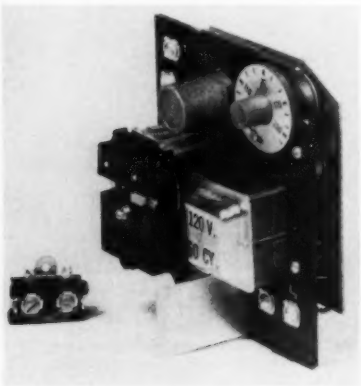
KEYS TO ADEQUATE LUBRICATION—**The familiar Dualine Valve manifolds, dual lubricant lines and central pumping station are the sign of Farval—the sign that a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.**

Above is the Portland conversion side milling machine on which ways are now protected by a Farval system.



Circle 661 on Page 139

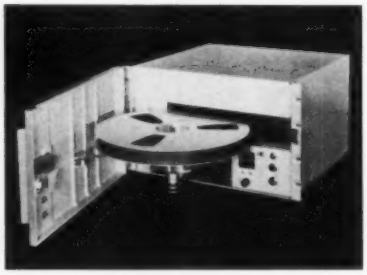
kins Inc. . . . **Charles F. Doepke** appointed manager of public relations and advertising for Fairbanks, Morse & Co. . . . **George C. Zentz** named supervisor of Methods Dept., Clearing Machine Corp. . . . **Paul K. Eckhardt** appointed manager of the General Apparatus Dept., Union Switch & Signal, Div., Westinghouse Air Brake Co. . . . **Leon Weiss** joined the Electronic Control Systems Div., Stromberg-Carlson, in the capacity of staff engineer . . . **Frank J. Fields** elected president of Fosdick Machine Tool Co. . . . **L. C. Schaefer** appointed vice president in charge of engineering for Torq Engineered Products Inc. . . . **Neal J. Dean** joined Booz, Allen & Hamilton as director of electronic data processing for the firm's central region . . . **Michael D. Bizzoco** named production manager of Tork Time Controls Inc. . . . **Charles C. Silva Jr.** appointed director of process engineering at Clevite Transistor Products, Div., Clevite Corp. . . . **George G. Brown** joined United States Testing Co. Inc. as director of engineering operations . . . **Robert W. Eager** appointed manufacturing manager of Joy Mfg. Co. . . . **Robert Strich** named chief engineer for the Los Angeles Div., Cannon Electric Co. . . . **Edmund R. Lehmann** appointed manager of application engineering for the Industrial Controls Div., Manning, Maxwell & Moore Inc.



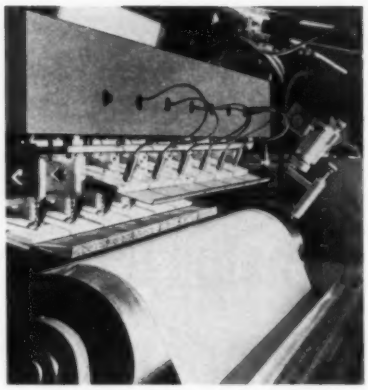
TRANSISTORIZED amplifier relay system for remote control of temperature in industrial applications has been introduced by Minneapolis-Honeywell Regulator Co. System consists of a transistorized amplifier which serves as the temperature controller and thermistor which acts as the sensing element. Thermistor and relay can be located two miles apart. System may be used to control air, surface, or immersion temperatures.

SPOTLIGHTING PRODUCTS

Recycling timers and timing kits in single, double, and triple gang assemblies are available from Herbach & Rademan Inc. Speeds vary from 50 cycles per minute to 1 cycle per hour. Units are recommended for process control applications, life testing, pulsing, and flashing. . . . *Stainless steel solder* in paste form has been developed by Eutectic Welding Alloys Corp. New solder alloy is painted on steel surface and indirect heat applied until the alloy flows and bonds at approximately 450 F. Alloy is oxidation resistant and remains shiny under corrosive conditions. In addition to stainless steel, alloy can be used with steels, copper alloys, and nickel alloys. . . . *Utility grade of preplated steel* is available from American Nickeloid Co. The new low-cost material comes in preplated finishes of chrome, nickel, or copper on a steel base and requires no cleaning, plating, or polishing by the user. It is readily adaptable to standard production techniques — stamping, blanking, bending, welding, seaming—without damage to finish.



AUTOMATIC bulk tape eraser developed by Ampex Corp. accommodates metal and plastic reels from 7 to 14 inches in diameter holding up to one inch wide tape. Reel of tape is placed on spindle and door closed, initiating automatic degaussing cycle. A controlled relative motion of both tape and degaussing field produces an erasing pattern with all signal and extraneous noise reduced below fundamental tape noise. Moments later, a green light signals completion of cycle. Designed for NARTB reels, unit can erase other reels by using spindle adaptor.

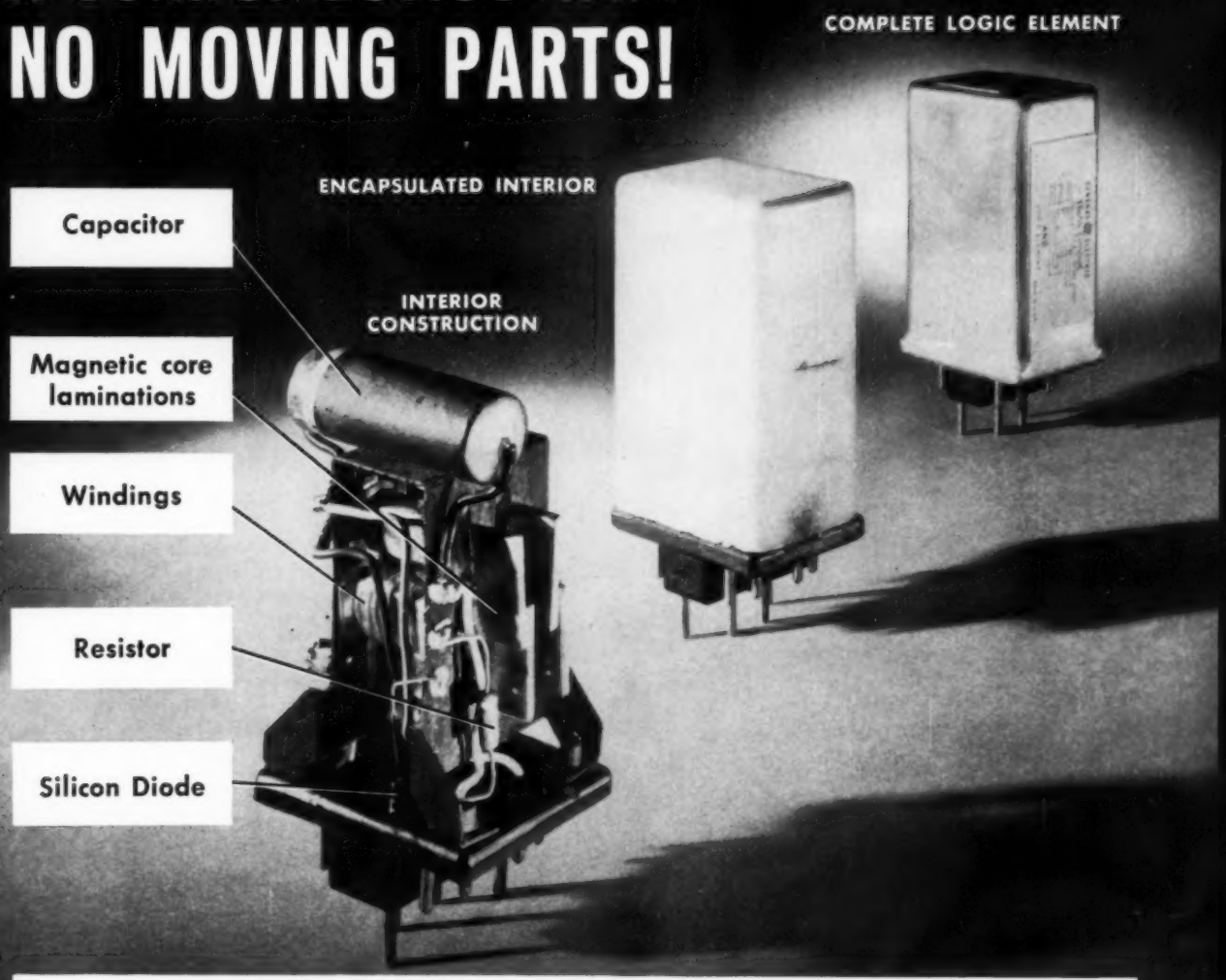


ELECTRONIC inspection device developed by Detectron Inc. detects, classifies, counts, and records paper imperfections while paper is being made at speeds up to 2000 fpm. Counterbalanced brushes sense voids, and stainless steel skids detect bumps. Imperfections are classified and marked on the trim edge of the paper for cutting out on later rewind operations. The unit can detect micron size holes and detect bumps as small as 0.0001 inch above the surface of the paper.

SPOTLIGHTING PLANTS

American MonoRail Co. has added an overhead cable conveyor to its line of products with the purchase of the assets of the Tipp Mfg. Co. . . . **Gulton Industries Inc.** has established the Glennite Instrumentation Div. for the development and production of sensing devices, data handling systems, and digital automatic computers. The new division will specialize in electromechanical and electronic instrumentation for complete monitoring and control systems in industrial and military applications. . . . **Island Equipment Corp.** is moving its general offices and manufacturing facilities from Long Island City to Miami, Fla. The company manufactures industrial conveyors and packaging-line equipment. . . . **International Telephone & Telegraph Corp.** is building a modern, air-conditioned plant near Roanoke, Va., to supplement its tube manufacturing facilities. . . . **Electro-Autosizing Machine Corp.** has severed connection with Industrial Gauges Corp. and has organized as an independent corporation in Closter, N. J. Their new factory building and facilities will serve the metalworking industry in providing precision gages and automation components. . . . **Bytrex Corp.** is the new name of the Metrix Corp. The new name was selected to avoid

A control device with NO MOVING PARTS!



General Electric static control: easy to apply, virtually maintenance free

Here's a control device which functions as a relay—but without moving parts or contacts to service and replace. It's a General Electric static control element. Its life is practically limitless, because length of life is *independent of the number of operations performed.* Maintenance costs and possible shutdown because of relay failure are virtually eliminated.

The General Electric logic element is the heart of a static control panel. It performs the same function that a relay does in a conventional circuit—but more efficiently, more dependably. To apply just express the machine operations in logic functions and apply the proper static control logic elements.

A major automotive manufacturer has designed several panels using G-E static control components. The electrical supervisor of their manufacturing development section says: "G-E components make planning static control relatively simple, and they're practically fail-proof. One machine, where maintenance could be a real problem, was equipped with a static control panel about 12 months ago. To date, there hasn't been an electrical control failure of any kind. We've already converted three machines to static control, and have immediate plans to convert several more."

Want more information on what static control with General Electric components can do for you? Simply call your G-E Apparatus Sales Office, or write Section 733-43, Schenectady, N. Y., for Bulletin GEA-6578.
General Purpose Control Dept., Bloomington, Ill.

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GENERAL ELECTRIC

Circle 662 on Page 139

NATIONAL ELECTRIC

solves tough production problem of welding air-suspension brackets for 1958 cars

The new air suspension systems introduced on some 1958 cars, create not only a super-smooth ride for passengers . . . but many production problems for manufacturers. To help lick one of these problems . . . National Electric designed and built two new multi-station arc welders that perform 2 important operations on the structural members of the new systems.

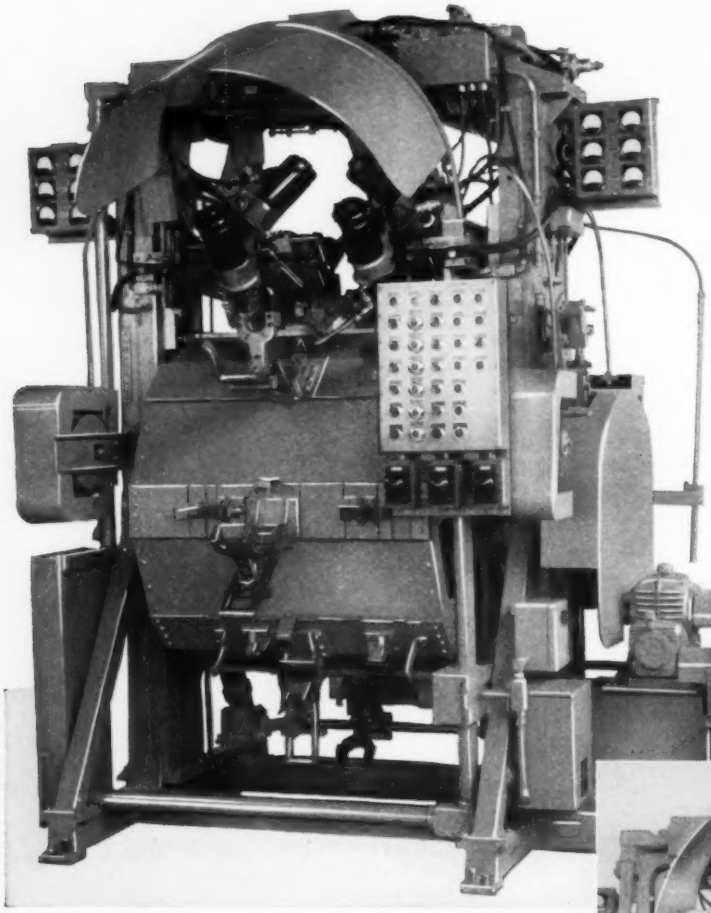
These 6-head, CO_2 arc welders incorporate a drum feed, 8-station Geneva Index, with 800 amp. rectifiers and dry type torches.

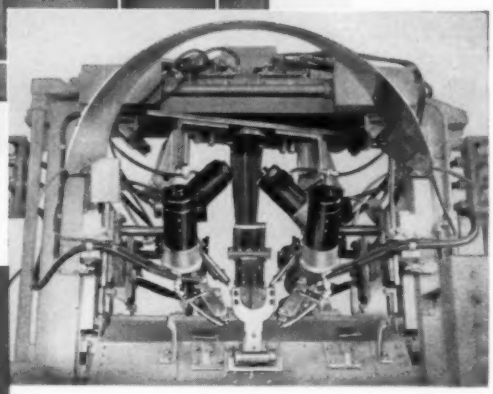
Structural members are manually clamped and automatically unloaded. The machines complete 6 welds in each cycle . . . two at each of three stations. There are four spot welds . . . and two curved fillet welds each two inches long.

The dwell time at each index is 1⅞ seconds . . . adjustable by electric clutch brake and timer for a dwell time of 3⅛ seconds, five seconds total, 12 cycles per minute or 720 cycles per hour. Actual production is approximately 600 assemblies per hour.

Tooling for the two jobs is interchangeable . . . so that either job can be run on either of the two machines.

This is another example of how National Electric designs and manufactures welding machinery for specific applications. If you have a production welding problem . . . National Electric can develop an automatic welding machine that will assure higher production and lower cost per weld. Write for complete information.





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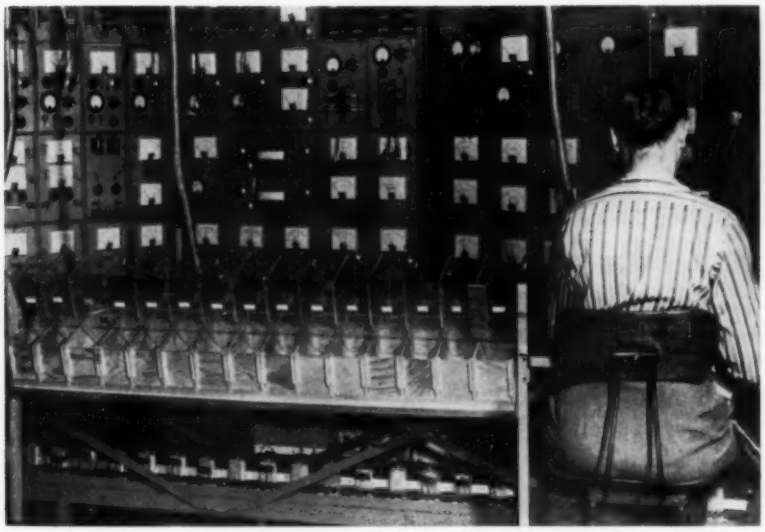
25 YEARS EXPERIENCE DESIGNING AND BUILDING: SPECIAL & STANDARD • AIR • HYDRAULIC • MOTOR DRIVEN • SPOT • PROJECTION • SEAM • BUTT • FLASH • RESISTANCE WELDERS • PRODUCTION FIXTURES FOR ALL TYPES OF AUTOMATIC ARC WELDING.

Circle 663 on Page 139



ELECTRICAL characteristics of vacuum tubes are automatically tested on a machine built and installed at Tung-Sol Electric Inc. Moving on a belt conveyor containing 80 test sockets, tubes are tested for up to 20 separate characteristics and are automatically rejected and sorted if found deficient. Machine tests approximately 1200 tubes per hour. The machine uses design principles that could be adapted for testing other electrical components and is built around 60 meter-relays furnished by Assembly Products Inc. Each meter-relay measures an electrical property, indicates its magnitude on a dial, causes a tube to be rejected if faulty, and resets its circuit for testing the next tube. The meter-relays also monitor all voltages used and automatically shut down the conveyor if improper test conditions develop.

confusion with other similarly named companies. The company manufactures instrumentation for strain gages and strain gage devices, and builds engineered systems based on these devices. . . . **Cleveland Crane & Engineering Co.** has started construction on a new research and development building at Wickliffe, Ohio. The building will include the engineering department, shop, and testing facilities for assembling, handling, and testing equipment under development.

MEETINGS AND EVENTS

June 9-12—

American Society of Mechanical Engineers. National conference on materials handling to be held in conjunction with the National Materials Handling Exposition at the Public Auditorium, Cleveland. Additional information is available from Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

June 9-13—

International Automation Exposition. Fourth International Automation Congress and Exposition to be held at the Coliseum, New York. The First Military Automation Exposition will be held at the same time and place. For additional information, contact Harrison Gilmer, Richard Rimbach Associates Inc., 845-A Ridge Ave., Pittsburgh 12, Pa.

June 12-14—

American Institute of Industrial Engineers. Ninth Annual National Conference and Convention to be held at Hotel Statler, Los Angeles. Additional information is available from S. J. Ross, Publicity Chairman, 329 E. Green St., Pasadena, Calif.

June 15-19—

American Society of Mechanical Engineers. Semiannual Meeting to be held at Statler Hotel, Detroit. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

June 15-28—

Industrial Management Center. Fifth Annual Material Handling Training Conference to be held at Lake Placid Club, Essex County, N. Y. For further information contact James R. Bright, Director, 56B

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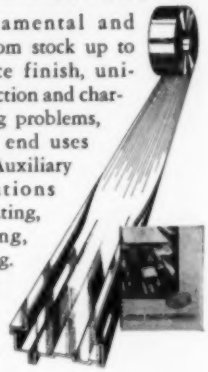
Structural, ornamental and tubular shapes from stock up to ½" thick. Surface finish, uniformity, stock selection and characteristics, plating problems, production costs, end uses and applications. Auxiliary automatic operations including perforating, notching, welding, coiling, embossing. 88 pages, fully charted and illustrated.



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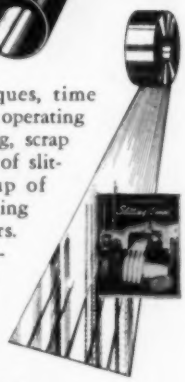
Operating techniques, time studies, analyses of operating cycles, coil handling, scrap disposal, selection of slitters and setting up of slitting lines, including coilers and recoilers. Advantages of slitting and how to compute "profit-point". 76 pages, fully illustrated.



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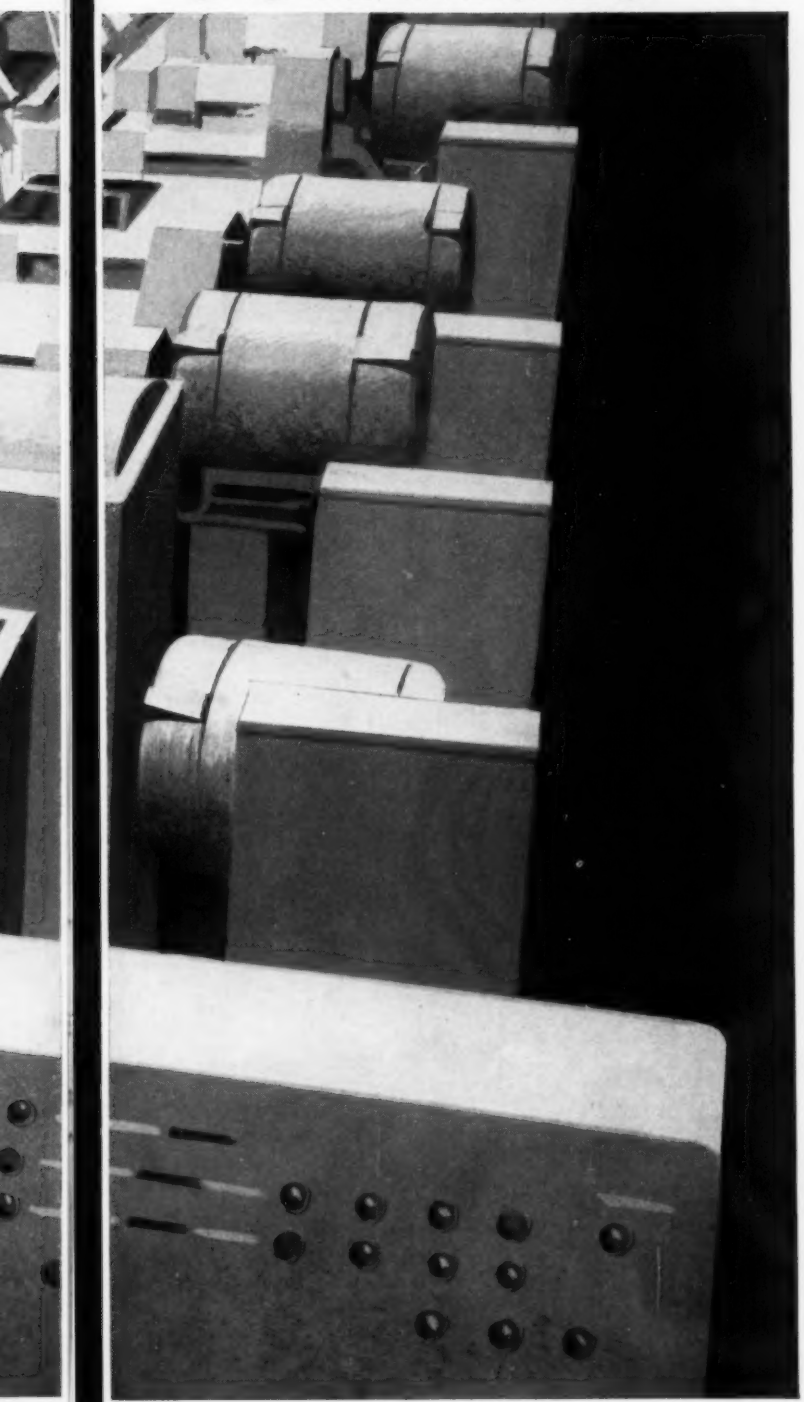
NEW PROXIMITY LIMIT OUTLIVE THE MACHINE IT

Westinghouse Products Developed for Modern Machine Tools

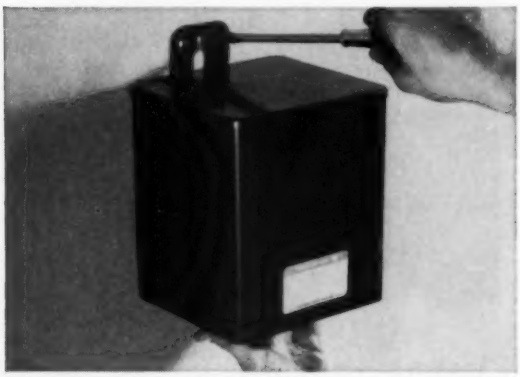
SWITCH WILL CONTROLS



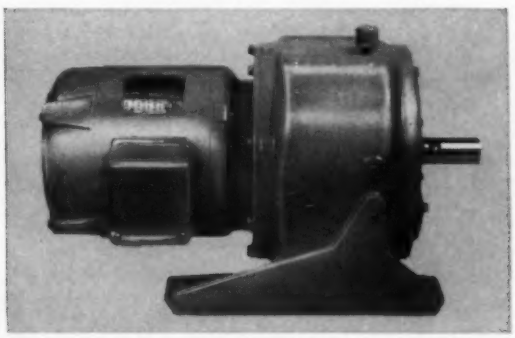
With the elimination of conventional mechanical parts, the new Westinghouse Proximity Limit Switch is the final link in a truly reliable control system. Developed and designed through practical research in Westinghouse engineering facilities, this new product is suitable for a wide range of application in the machine tool industry.

Westinghouse products like this are the sign of a modern machine tool, designed to give the most production at the lowest possible cost. An electrical system, designed and supplied by Westinghouse industry-experienced engineers, is sure to give the best in long-term economical service.

For complete information about Proximity Limit Switches and the other Westinghouse components for modern machine tool systems, ask your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-96110-R



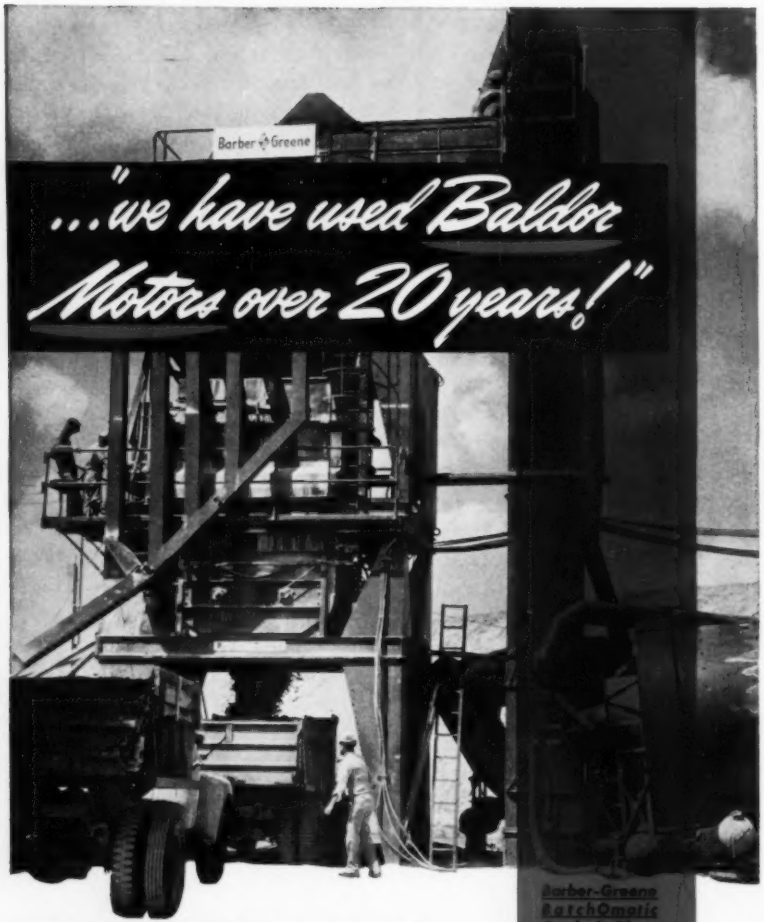
Westinghouse EP Machine Tool Transformers cut space requirements up to 50%, can be mounted in any position. Accelerated life tests indicate new design doubles normal machine tool transformer life.



New Moduline Gear Units use 15 basic subassemblies to standardize over 20,000 gearing configurations. One wrench modifies any unit. Gears meet AGMA "master-gear" standards for quiet, maintenance-free operation.

YOU CAN BE SURE...IF IT'S
Westinghouse

Circle 664 on Page 139



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June 22-27—

American Institute of Chemical Engineers. 50th Anniversary Meeting to be held at University of Pennsylvania, Philadelphia. Further details are available from Joseph I. Savoca, Socony Mobil Oil Co., Paulsboro, N. J.

June 22-27—

American Society for Testing Materials. 61st Annual Meeting to be held at Hotels Statler and Sheraton-Plaza, Boston, Mass. Additional information is available from Albert L. Batik, ASTM headquarters, 1916 Race St., Philadelphia 3, Pa.

June 23-27—

American Institute of Electrical Engineers. Summer General Meeting to be held at Hotel Statler, Buffalo, N. Y. Further information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

July 28-Aug. 1—

Gordon Research Conferences. Instrumentation Conference to be held at Colby Junior College, New London, N. H. Additional information is available from W. George Parks, Director, Colby Junior College, New London, N. H.

Aug. 11-13—

Western Packaging & Materials Handling Exposition. 1958 Show to be held at Civic Auditorium, San Francisco. Additional information is available from William J. Wilkin, Clapp & Poliak Inc., 759 Monadnock Bldg., San Francisco 5, Calif.

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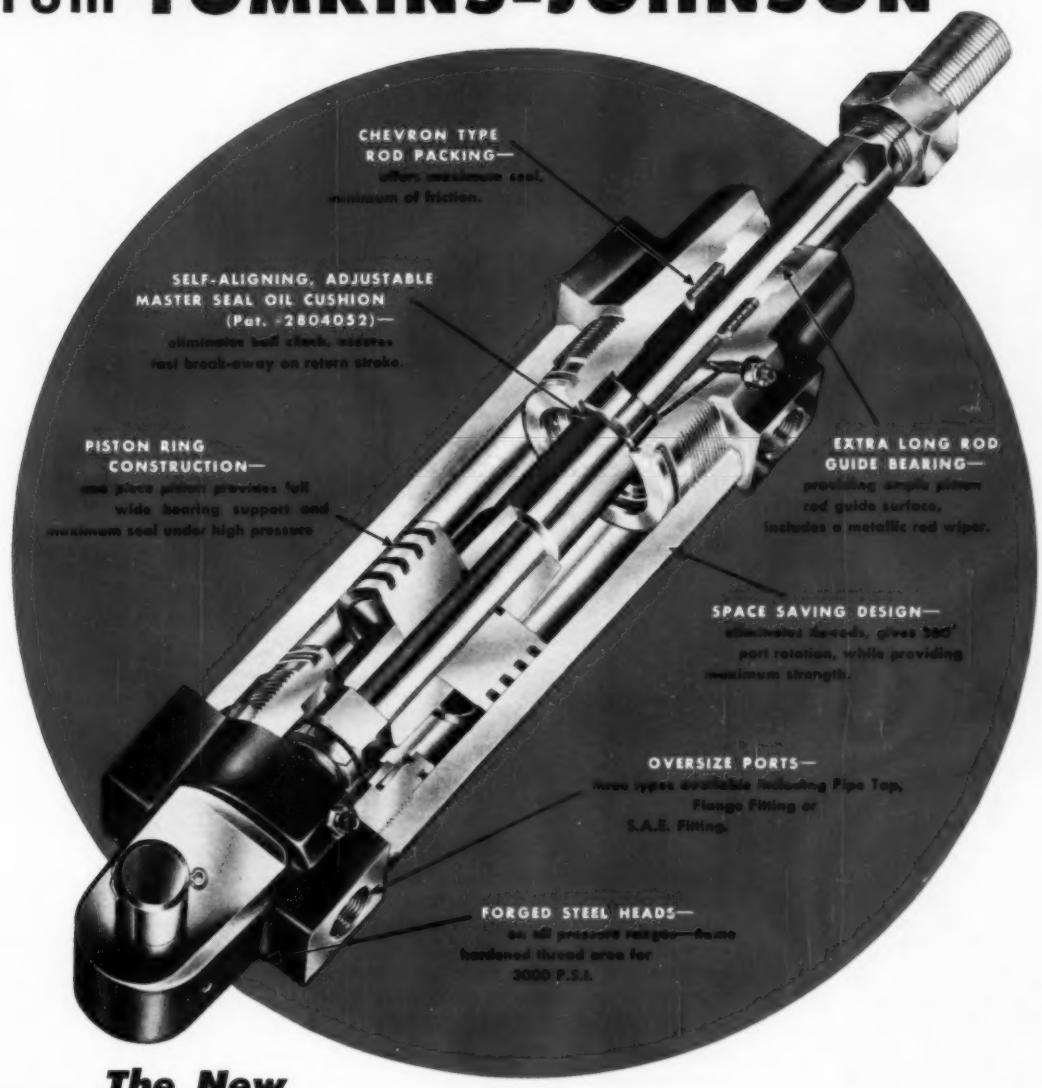
Another Engineering First

from TOMKINS-JOHNSON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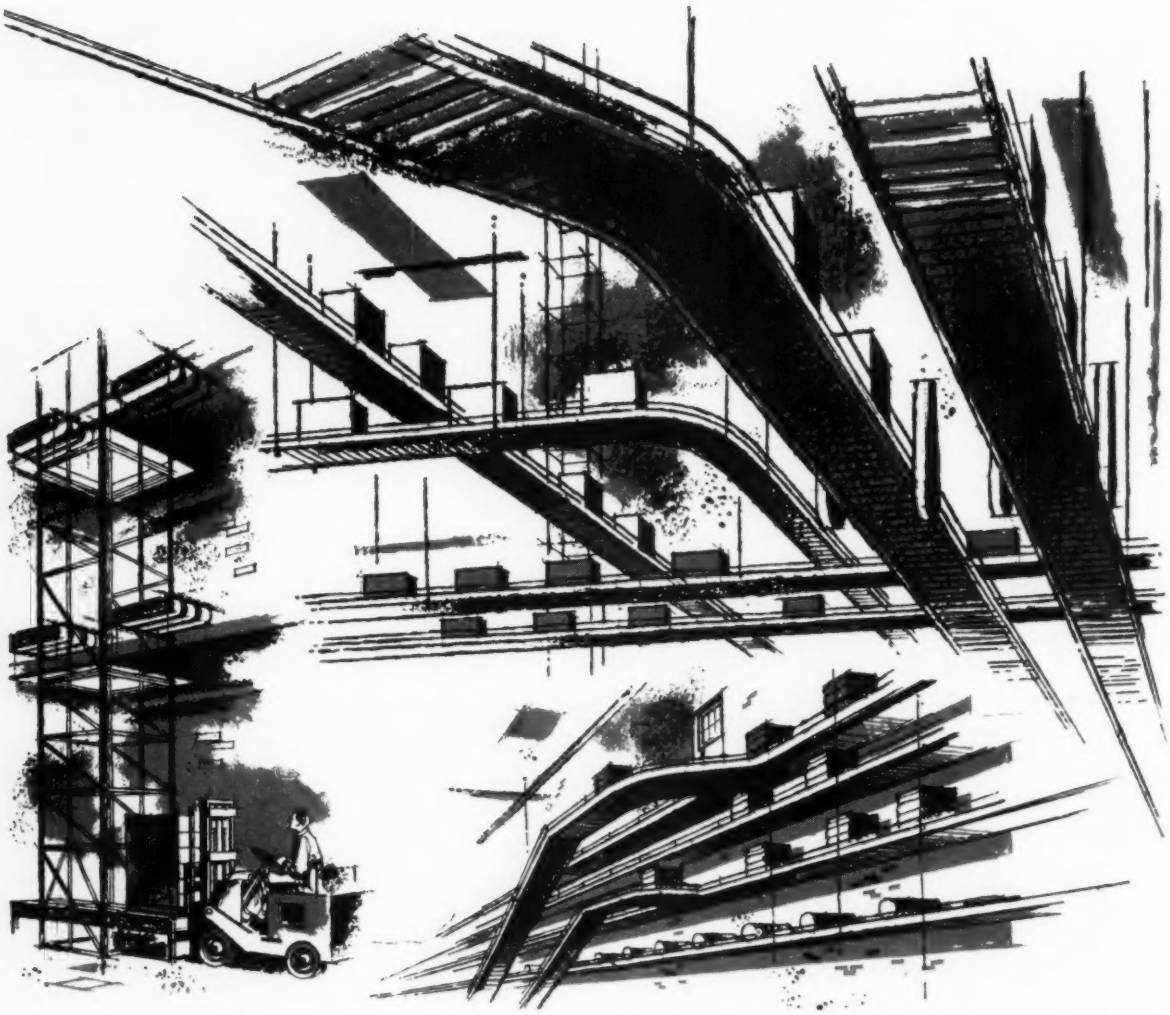

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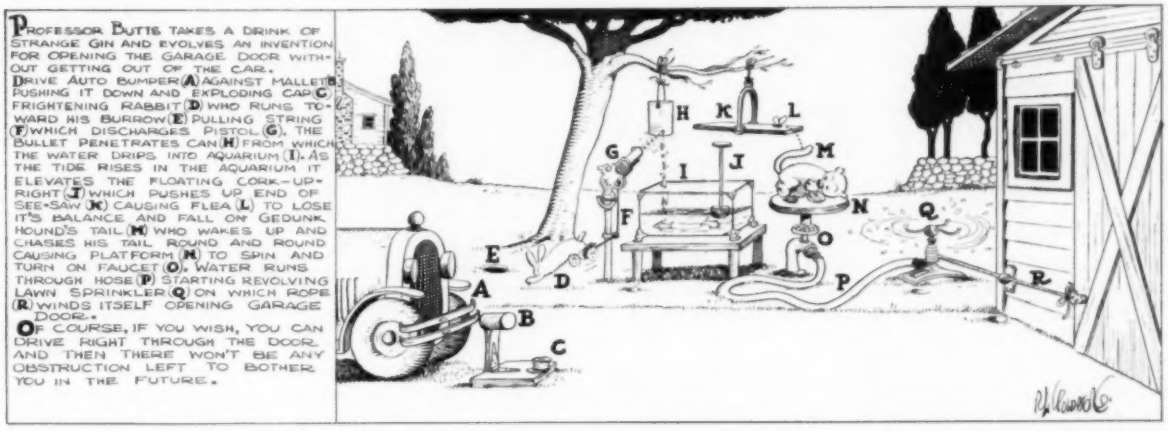
By JAMES C. KEEBLER Managing Editor


PROFESSOR BUTTS TAKES A DRINK OF STRANGE GIN AND EVOLVES AN INVENTION FOR OPENING THE GARAGE DOOR WITHOUT GETTING OUT OF THE CAR. DRIVE AUTO BUMPER (A) AGAINST MALLET (B) PUSHING IT DOWN AND EXPLODING CAP (C) FRIGHTENING RABBIT (D) WHO RUNS TOWARD HIS BURROW (E) PULLING STRING (F) WHICH DISCHARGES PISTOL (G). THE BULLET PENETRATES CAN (H) FROM WHICH THE WATER DRIPS INTO AQUARIUM (I). AS THE TIDE RISES IN THE AQUARIUM IT ELEVATES THE FLOATING CORK-UPRIGHT (J) WHICH PUSHES UP END OF SEE-SAW (K) CAUSING FLEA (L) TO LOSE IT'S BALANCE AND FALL ON GEDUNK HOUND'S TAIL (M) WHO WAKES UP AND CHASES HIS TAIL ROUND AND ROUND CAUSING PLATFORM (N) TO SPIN AND TURN ON FAUCET (O). WATER RUNS THROUGH HOSE (P) STARTING REVOLVING LAWN SPRINKLER (Q) ON WHICH ROPE (R) WINDS ITSELF OPENING GARAGE DOOR. OF COURSE, IF YOU WISH, YOU CAN DRIVE RIGHT THROUGH THE DOOR, AND THEN THERE WON'T BE ANY OBSTRUCTION LEFT TO BOTHER YOU IN THE FUTURE.
A
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Cartoon *(above)* is an original Rube Goldberg invention drawn over 40 years ago by Reuben Lucius Goldberg. Note the signature *R. L. Goldberg* which predates the use of the nickname *Rube* on his work. Inventions of this type brought fame to their creator *(right)* who currently draws editorial cartoons for Hearst papers.

A Real Rube Goldberg

ONE of the more interesting phenomena that can be experienced in most modern machine shops is to walk through the premises with an enthusiastic manufacturing engineer who swells with pride as he approaches a strange mechanical contrivance that consists of assorted quantities of angle iron, two by fours and baling wire, and to hear him boast with a grin, "Here's a real Rube Goldberg."

Meaning Clear

If the observer should be curious enough to question the meaning of the expression by asking, "What's a Rube Goldberg?", he will invariably be answered in a manner that indicates astonishment that the question had to be asked. Everyone, but everyone, knows that a Rube Goldberg is a complicated system of machine elements ingeniously arranged in such a manner as to automatically accomplish some end result.

Such machines are usually characterized by an appearance of having been "cobbled" together—"the most of it looks like an afterthought." Another characteristic is that despite the haphazard look about them, these machines really work.

As with many of the terms used in industry, it is not difficult to get a clear idea of the definition of a real Rube Goldberg, but there are few who use the saying who can explain much about its origin. To the younger production engineers this is just part of the folklore of the shop passed on by oldtimers.

California Born

Rube Goldberg got started in San Francisco on July 4, 1883 when Max and Hanna Goldberg became the proud parents of a bouncing baby boy that they chose to name Reuben Lucius.

Though he graduated from the University of California with a degree in mining engineering, this lad was more interested in cartoons, so he went to work for the San Francisco *Chronicle*. Rube Goldberg moved to New York City in 1907 and became famous as a cartoonist.

Oldtimers in the shops remember Rube Goldberg as having entertained the nation in the twenties and thirties with funnypaper characters such as Boob McNutt and Professor Lucifer Gorgonzola* Butts.

The professor was always coming out with a new invention that used an elaborate series of actions to accomplish its final result. Strings, trap doors, insects, animals, firearms, water power (static and dynamic) and its accompanying piping often gave a healthy assist to the better-known machine elements such as levers and wheels.

The basic theme of the Butts inventions was to utilize the host of machine elements in a chain-reaction which the reader would follow through its torturous sequence of cause and effects until the conclusion was reached. The reader was aided by a manuscript with key letters referring to the illustration. The machine was always highly complex, and the conclusion was always trivial. The Professor saw fit to end his descriptions with an alternative proposal which was always quite simple by contrast, but preposterously impractical.

In 1934 Rube Goldberg quit the

*Gorgonzola is defined by Webster as a kind of Italian pressed milk cheese resembling Roquefort;—from a village near Milan.

funnypapers for more serious magazine, advertising, and newpaper work. In 1948 he was awarded a Pulitzer prize for an editorial cartoon on atomic energy he did for the New York *Sun*. Goldberg has also been honored by Sigma Delta Chi, professional journalistic fraternity, for his talents as an editorial cartoonist.

Now at the ripe age of 75 the real Rube Goldberg still maintains a studio in New York—does three editorial cartoons a week for the Hearst papers plus some advertising illustration and an occasional item for the good causes of the nation.

His latest book, *Rube Goldberg Goes to Europe*, was published in 1954. The next book deals with automation and is scheduled to be published by Doubleday the early part of 1959. These works show that although Professor Butts stopped inventing over 20 years ago, Rube Goldberg has never stopped doing inventions.

"What is it about machinery that's funny?" he asks. Tour a machinery show and observe the attendees—their faces light up with everything from a simple smile of satisfaction to a laugh of humor as they see mechanisms perform. To Rube Goldberg the humor has always lain in the presence of a maze of complexity to produce relatively simple end products. It takes all that, just to do this little bit. He would nominate a Lifesaver factory as the funniest of all. Here are huge equipment installations just to make a little piece of candy with a hole in it.

Ingenious Hodgepodge

Though the immense talents of this man have won him wide acclaim outside of the field of invention, it is certain that his name will live on in the vernacular of the machine shop. Whenever an inventive mind sees a better way to do a job it's usually not long until a homemade attachment is clamped in place on a machine just to "give her a try."

Often one idea leads to another and soon there's a Rube Goldberg spitting out parts like mad. Because this state of affairs is industrially symbolic of the early stages of machine development, some engineers feel compelled to apologize for such machines. In the machinery building trade such appearances are the mark of a back-alley shop, and many machine builders would take serious offense if the term were applied to their wares.

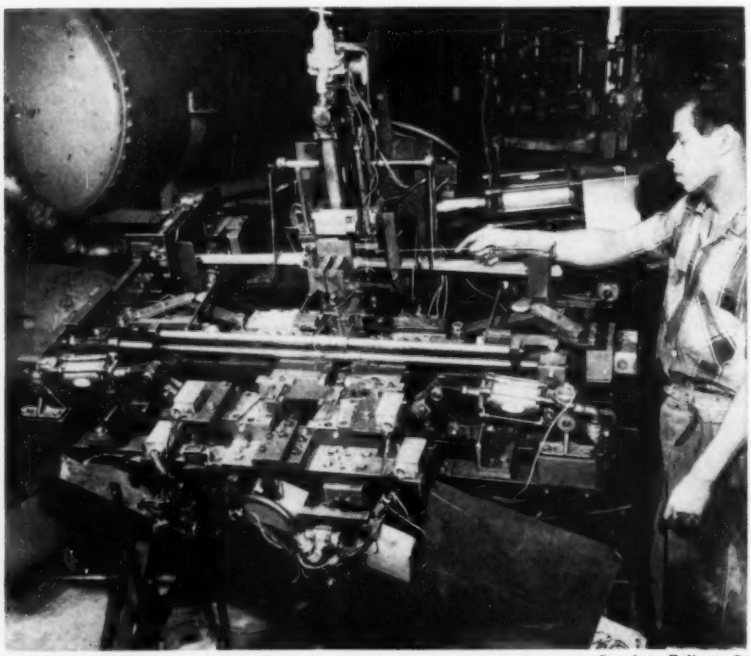
So it is often recognized that in many instances, although a Rube Goldberg machine actually works, it represents a stage of development beyond which the user hopes to go. In speaking of the development of automated production processes Ford's Ray Sullivan has said: ". . . pre-war automobile plants . . . were marvelous all right, in the same way that a Rube Goldberg contraption is marvelous. You admired their complexity and perhaps wondered what held them together."

In the process of refining that which appears to be a hodgepodge operation into a smooth running production system the manufacturing engineer devises methods that are based on the essential steps of the original development. The systems approach to the study of production processes is becoming the byword of automation engineering.

What Rube Goldberg did 40 years ago in jest is now being seriously recognized as an essential consideration in process planning. This is the recognition of a chain-reaction type sequence inherent in processing. In Professor Butts' invention for opening a garage door without getting out of the car, the flea is of itself not as important as is its relationship to the seesaw that activates it, and its relationship to the gedunk hound it irritates. Whatever other characteristics the flea may possess, these are the important ones in this process. The systems approach considers each step's reaction on the others and not each step as an entity.

General Electric's Dr. W. R. G. Baker summed up this marvel of history by suggesting that Rube Goldberg be named the inventor of automation. This too might give some a big laugh, but few will deny that there's a lot in common between Goldberg and automation.

Despite the advances in production equipment design techniques and the strides of automation there is every reason to believe that industry will go right on putting Rube Goldbergs together. The step by step evolution of better methods will always have the appearance of being cobbled together. Many "advanced" machines will still be the old contraption with a fancy cabinet to hide it. And the production engineer will always yearn to create a real Rube Goldberg—a system that works every time just like it was planned on paper.

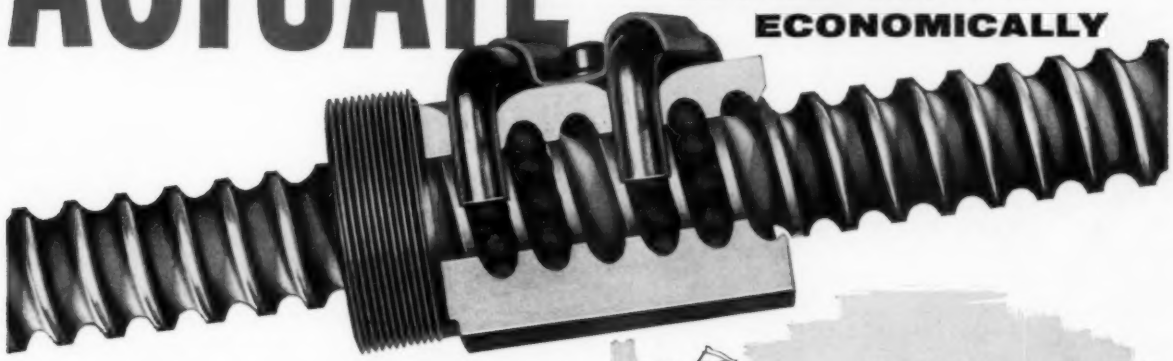


Courtesy Bellows Co.

Typical Rube Goldberg machine is a shop-built piece of toymaking equipment that forms and bends wires into loops used as tracks for magnetic wheels.

ACTUATE

MORE QUICKLY . . .
EFFICIENTLY . . .
ECONOMICALLY



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.375" .631" 1.000" 1.171" 1.500" 2.250" 3.000"

MANY TYPICAL APPLICATIONS

Saginaw b/b Screw standard assemblies have been successfully applied to such products as bumper jacks, automatic garage doors, automobile seat adjusters and window lifts, beauty parlor chairs, hospital beds, and circuit breakers. They are also being used in heavy industrial equipment like die table positioners, drill presses, lift trucks and welding machines.

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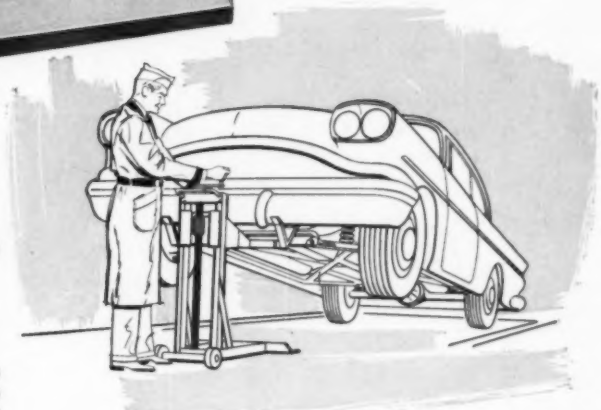
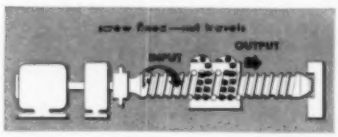
Saginaw
ROLLED THREAD ball bearing Screw

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.



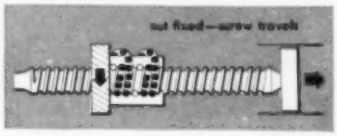
With a Saginaw b/b Rolled Thread Screw in the jack, just a spin of the handle raises a heavy car easily . . . smoothly . . . safely.

HOW THE WORLD'S MOST EFFICIENT ROTO-LINEAR DEVICE WORKS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque.

SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with new efficiency.



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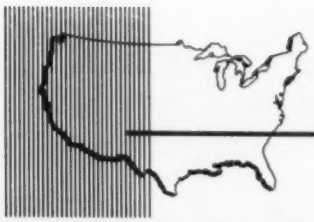
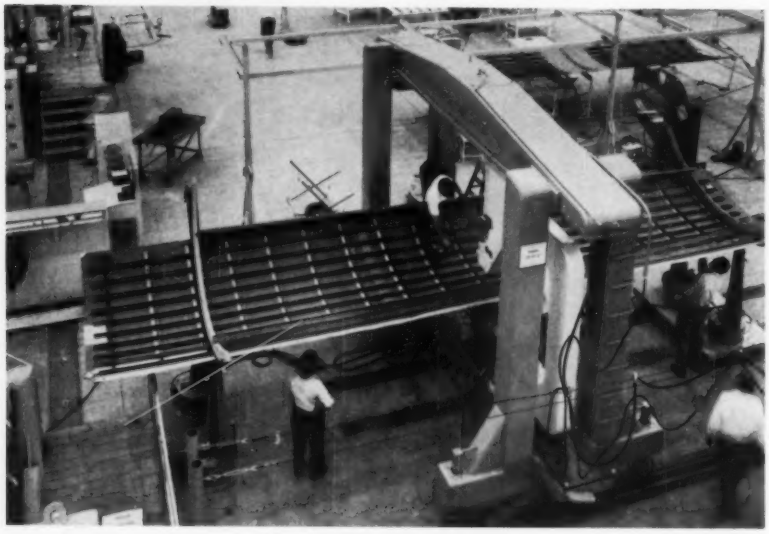


western roundup

By GILBERT C. CLOSE
Hawthorne, Calif.



Automatic riveting equipment for large airframe members is typically designed to move workpieces relative to a stationary head. Contrasting with this usual approach, the illustrated Manco Cripsin setup provides for the riveting head mounted on the gantry to move relative to the work. The part is a portion of a DC-8 Jetliner fuselage being fabricated at Douglas Aircraft Co.

Data Details

NUMERICAL-controlled machines, in conjunction with simplified techniques for transferring blueprint information into serial information on punched paper tapes, then retransferring this serial information into parallel information across the width of a magnetic control tape, are belying the once quite firmly established idea that economical and successful automation depended largely on repetition. Tape controlled machines can produce one or a dozen similar parts, then turn suddenly about and produce a few entirely different parts with only minor effort required.

In fact, automation to date in the large airplants, has leaned more toward the production of diversified complex components by numerical control than toward anything else. This was a necessity in plants where 200 parts would be considered an exceptionally large production run.

Current developments in west coast automation indicate that these versatile numerically controlled units will soon find even wider use, pushing outward, so to speak, into the many shops and plants serving the aircraft industry as subcontractors. One of the most important developments at this time is the recent establishment in Los Angeles of an automation data service to supply operating tapes for numerically-controlled machine tools to users throughout the nation. According to Robert C. Tait, president of the Stromberg Carlson Div., General Dynamics Corp., the company spearheading this development, users of the new service will find that sending in punched paper tapes for transposing into numerical control tapes is as simple as sending color film to the laboratory for processing.

Three high-speed special-purpose computers, or "directors" as they are more commonly called, are being procured under a contract with the U. S. Air Force. These directors will be used to furnish the tape service to a number of users of numerically controlled machine tools equipped with "Digimatic" controls as designed by the Electronic Control Systems Division of Stromberg Carlson in Los Angeles. As a result of this new service, the ECS backlog for Digimatic control and director equipment to be used in this program is well in excess of $1 million.

Tools for using the tapes produced by this new service will be furnished by the Air Force to aircraft manufacturers engaged in vital military defense programs, and are expected to be distributed on a nation-wide basis. Extension of this service to civilian users of Digimatic controlled machines is also planned.

In using the new service, fabrication of the machined parts will be specified by the aircraft manufacturer's tooling men themselves. The data for fabrication will be taken directly from the blueprints, and the process detail will be punched into permanent storage on paper tape using a simplified ECS keyboard unit. These punched paper tapes will then be sent to the nearest processing center for conversion to magnetic control tapes. Rapid handling, processing, and return delivery will be a factor in the new service to speed production. The time required for tape processing will, on the average, be only a small fraction of the time formerly required to design and build the special tooling and fixtures required for conventional fabrication.

A substantial expansion of the Digimatic tape processing center in Los Angeles is now under way. A fourth new director unit is scheduled to be in operation yet this year. The expanded facilities are also being geared to provide rapid tape service for a family of low-priced commercial numerically controlled

"We get ten refrigerator pans a minute...

from one press and with one attendant!" From its motorized coil cradle to its mechanized conveyer, this is a truly automated production unit. Coil stock feeds through the press' seven transfer stations... is easily formed and drawn into deep drawn refrigerator pans. Bliss engineers design and build entire systems like these, including the dies.

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Circle 669 on Page 139

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You can save on engineering and manufacturing costs by building your *special* machines the same way Baker does — out of Baker's *standard* components. Build with standard hydraulic slides and power units . . . one of the Baker Basic models will fit 9 out of 10 applications. You save, and you actually get a better machine from Baker design-tested components.

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AUTOMATION

Best in the long run
Practical in the short run

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Send me prices and comprehensive 2-page data-spec-dimension sheets on these standard Baker components . . .

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CHECK HERE	WIDTH OF-WAYS	CAPACITY HP MAX.
( )	11	5
( )	12	15
( )	18	15
( )	18	25
( )	20	50

( ) Drive box for above slide
( ) Porta-Pak hydraulic power unit
( ) Standard index tables

units equipped with Bendix and General Electric controls now being offered by Kearney & Trecker Corp. and Morey Machinery Co.

A big advantage of this trend toward numerical control is already evident in many large airplants. Rather than a vast array of tooling and fixtures which required weeks of time and thousands of dollars to produce, and which occupy much valuable plant space, many of the $150,000 numerically-controlled machine installations are "tooled" by a few rolls of magnetic tape stored in a cabinet convenient to the operator. With a hundred such control tapes on hand, the operator stands ready to produce a hundred different components with little more effort required than to mount the tool and blank part in the machine, install a tape on the control mechanism, then push a button and sit back and wait.

And even this period of waiting has been drastically reduced. The operator of a huge numerically-controlled mill in the Convair plant at San Diego had just finished a complex cut on an airplane wing spar component in 40 minutes time, floor-to-floor. This writer then asked him how long it would have taken to make the same cut on a conventional hydraulically controlled machine. The answer was revelent of the possibilities inherent of numerical control. The man calculated for a moment, then said, "About 11 hours to set up and make the cut."

The A.I.A. Reports . . .

The military services will produce a saving "conservatively estimated at millions of dollars" by using a new electronic data processing technique developed in conjunction with the aircraft industry. This new system will permit instantaneous exchange of large masses of spare parts data between the electronic machines of contractors and military bases. The interchange will be accomplished through direct telephone hook-ups.

Using the new technique, electronic processing permits 200 related pieces of information regarding each spare part to be recorded. Any current information can also be quickly added. The machines can process data at a rate of 15,000 characters per second, with a recording density of 200 characters per inch of tape.

Circle 670 on Page 139

how to give any air cylinder...

Hydraulic Smoothness

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You can make any air cylinder piston rod behave with Bellows Hydro-Check* control. This precision control unit, mounted parallel to, or in line with the air cylinder, sets up an opposed, steadying control force that smooths out chatter instantly.

You can have Hydro-Check control when you want it—for a fraction of the stroke, or all of it. With certain models of Hydro-Checks you can have "Skip"—or intermittent checking action; or you can stop an air cylinder piston at any point in its travel for a predetermined time and then resume traverse. Hydraulic control can be on either advance or retract strokes or on both.

*T.M.Reg.

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Circle 671 on Page 139

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for lubricants and materials assure

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- **Top Performance**
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Power-Master ... years-ahead design gives industry a complete range of dependable, high performance pumps to handle all materials from light oils to heavy fibrous greases and viscous coatings, sealers and mastics. No limit to industrial applications ... cost far less than comparable pumps to operate and maintain. Available in a great number of pressure ratios.

It pays to standardize on Power-Master

HIGH VOLUME OUTPUT — **Air Motor** features extra long stroke for powerful, uniform delivery on both up and down strokes. **Shovel-Type Foot Valve** adds mechanical priming to normal suction ... assures positive prime with all industrial lubricants even at lowest temperatures.

STURDY CONSTRUCTION — Plunger and Bushing of case hardened Nitraloy steel ... prolongs life ... resists wear. Pump Outlet Body of all steel, one-piece construction ... hydrogen brazed. Withstands constant pulsation and extreme pressure. All moving parts are of tough, heat-treated steel.

TROUBLE-FREE, POSITIVE PERFORMANCE — Air Motor operation is 100% pneumatic ... no springs to wear out, rust, or lose tension. Air Valve is stall-proof, leak-proof and pre-lubricated ... toggle action assures positive tripping.

HIGH EFFICIENCY — Advanced design, double-acting **mechanisms** assure dependable low surge operation with minimum air consumption. Large **air passages** allow unrestricted venting.

PRECISION MADE — All mating surfaces of plunger, Bushing and Air Valve are microlapped to high tolerance ... prevents by-passing lubricant or bleeding off air. No washers or packings to replace.

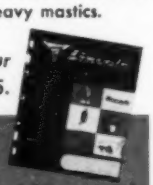
SIMPLIFIED MAINTENANCE — Modular design of **Pump Tubes** provides extreme ease of disassembly ... invaluable when using compounds which may "set up," such as paints, plastics, etc. Entire mechanism can be assembled only "hand tight" and function perfectly for an indefinite period. **Air Motor Piston** and **Cylinder** ... No oiling required ... minimum friction ... no leather cups.

LIGHT WEIGHT — Generous use of aluminum makes **Pump** amazingly light in weight and distributes heat to prevent "icing" of **Air Valve.**

QUIET OPERATION — Exhaust port is free-flow in design and shielded by sleeve to produce a natural muffling effect.

INDUSTRY-WIDE APPLICATIONS — **Five Pump Tubes** are available for the POWER-MASTER series providing 19 ratios from 2 to 1, to 75 to 1. Meets all Industrial requirements. Handles all materials, from light, volatile solvents to heavy mastics.

For complete information on the new Power-Master series, contact your nearest Lincoln distributor ... and write for new Lincoln Catalog No. 65.



Lincoln

LINCOLN ENGINEERING COMPANY

Division of The McNeil Machine & Engineering Co.

5794 Natural Bridge Avenue • St. Louis 20, Missouri

Idle Time

A fundamental approach inherent in today's trend in business is typified by the economics of automated home and farm operations. As farm labor has diminished, the farm has gone automatic. Some equipment is used intermittently, some once a day, some once a week, some once a year. But total productivity has continued to rise, along with output quality and incomes. In the light of conventional business economics, the farm and the home might be considered woefully overcapitalized with largely idle machinery. However, when a job needs to be done, it is accomplished with top efficiency.

Few major chores on the farm today need to be done manually. Automatic equipment is available and used for all levels of operation. Even special feed formulas can be automatically selected, mixed and ground for everyday use. On the basis of general industrial equipment policy, however, machinery that lies idle for any length of time would not be condoned. Perhaps a fresh look at costs and a break with past methods of analysis are needed to see the true picture.

We find automated lines today beginning to duplicate the pattern of the farm. Part-time automatic equipment is making it possible to produce at the desired economic level. Production machines start up automatically on signal from the line that supply is needed. Like a heating plant that operates only when the building thermostats call for heat, much automated equipment will have to be looked on as a fundamental part of a larger overall productive system rather than a separate piece of independent equipment that is often idle.

Farm machines are not evaluated on an individual basis, but rather are considered in their relative importance as parts of an integrated production system. Many industrial systems will parallel this pattern. In place of the incredulous comment, "but it only runs a few hours a day!", there should be some realistic study of the changing cost pattern in manufacturing.

Automated capital equipment will economically produce tomorrow's products and help create tomorrow's profits.

EDITOR

AUTOMATION

Fig. 1—Prototype numerical controlled transfer line contains, left to right, a milling, a drilling, and a boring machine. Controls for the equipment were developed by Hughes Products; machine tools were developed by Kearney & Trecker Corp.

TAPE CONTROLLED TRANSFER MACHINE

HANDLES DIFFERENT PARTS SIMULTANEOUSLY

Most of the machining done by industry falls into the area of small-lot production. Continual technical progress has opened up more and more of this efficiency-starved area to the benefits of automatic operations. One of the most recent revelations is an automatic machine line controlled by punched tape.

SUCCESSFUL application of numerical controls to single machine tools has presaged development of numerical control systems involving a multiplicity of machine tools. This vision of a system, which in effect is a marriage between the concepts of transfer machining and numerical control, is now a demonstrated reality—indeed, real enough to have logged approximately one year's experience on the prototype models with the promise of production designs ready for delivery during 1958.

The early availability of such an advanced equipment system attests to the rapid acceptance of numerical control by responsible equipment suppliers and their faith in the value of the concept

to industry. In April 1955, the Industrial Systems and Controls, a division of Hughes Products, launched a program for development of tape controls to operate machine tools used by Hughes Aircraft Co. in the manufacture of airborne armament control systems. Initial economic studies indicated that a machine tool line combined by numerical controls would be extremely useful to the metalworking industry in general in view of the prevalence of job shop and small quantity production operations. In January 1956, Kearney & Trecker Corp. undertook the development of the machine tools to complement the controls being developed by Hughes.

The prototype result of this combined effort between Hughes and Kearney & Trecker is a numerically controlled line, *Fig.* 1, containing a horizontal milling machine, a drilling machine provided with means for automatically selecting tools from a turret, and a boring machine with two spindles that can be adjusted electronically for different size cuts. These three machine tools are joined by a shuttle-type transfer mechanism which moves fixtures containing workpieces between the worktables of the individual machines. Except for manual load and unload of the fixtures, complete operation of each machine tool in the line, and the line as an entity, is accomplished automatically under the direction of punched tape. The net result is a transfer line composed of versatile tools—a system which is capable of bringing transfer line advantages to the simultaneous production of four different parts.

To obtain this degree of flexibility, the control system (called Digitape) contains that number of tape readers that equals the number of work stations in the line. Considering the need for a part in the ready position ahead of the first machine, four tape readers are used in a three-machine line.

The punched tape in any one reader contains all of the control information for one part. As the part advances in the line from one machine to the next, the tape reader automatically switches to control the different machines. Thus, by inserting four different tapes in the readers, it is possible to machine four entirely unrelated parts, *Fig.* 2. To machine a quantity of an individual part, four indentical tapes would be needed.

▶ Tape Preparation

Foreseeing the importance to the user of simplicity in tape preparation, the control designers developed a system which can be programmed with a minimum of computations by the planner. Numerical data from a drawing is listed on a planning sheet in decimal form. In addition, the planning engineer lists the proper sequence and data for machining operations, index table movements, and other supplementary information. For instance, positioning can be programmed to operate on a single axis mode if interference is a problem. Or to save time in positioning, the tool can operate on a multiple axis mode in which case, movement takes place simultaneously along all axes in positioning the tool. This feature is available for each individual positioning operation. Also, in programming a given operation, the planner has the option of using information already on the tape. This

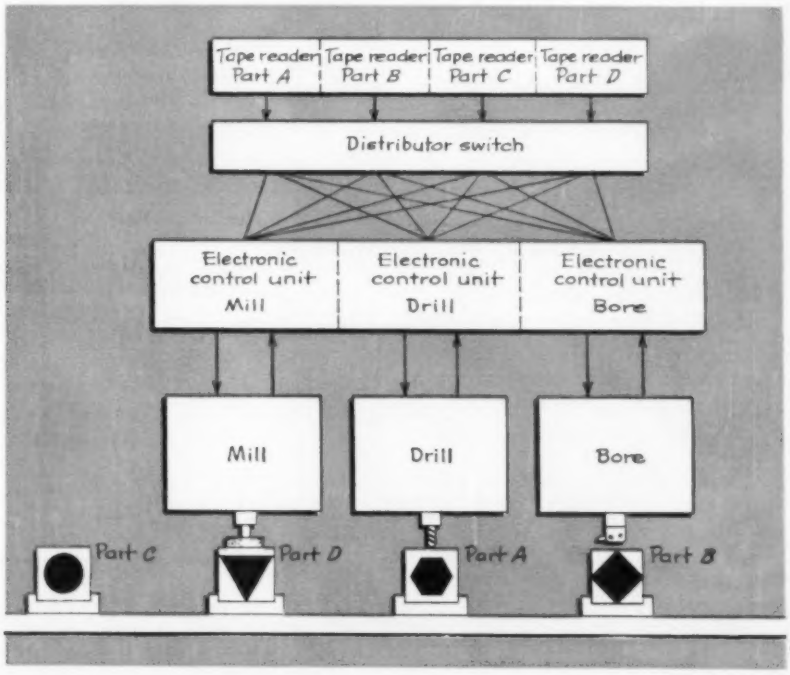


Fig. 2—System provides for simultaneous machining of four unrelated parts. Tape in a reader controls all of the machines necessary to work on one part. Part can be indexed to 4 positions, 90 degrees apart, by worktables of each machine.

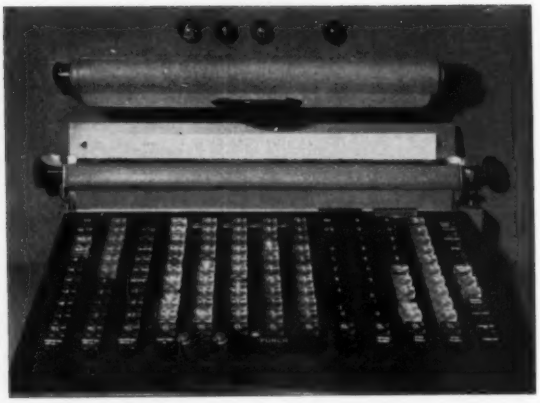


Fig. 3—Information is placed on simplified planning sheet. Dimensional information is programmed in decimal form. Typist uses special keyboard to prepare tape. Equipment automatically punches tape in binary coded decimal form.

means that he can change the reference position from which he takes dimensions, making it unnecessary to return to zero reference point for all commands.

A length of tape containing the dimensional information for a given operation also contains space in which up to two modifications in originally punched data can be made. This type of modification can be made without disturbing any other data on the tape. These extra punches, which provide up to 0.014 inch modification in any dimension, can be made on the machine shop floor.

The planning sheets containing the data for a given workpiece are turned over to a typist for tape preparation. Equipment for tape preparation contains a special keyboard, *Fig.* 3, and features which prevent punching of incomplete instructions on the tape. As the typist punches keys corresponding to numbers and symbols contained on the planning sheet, the information is automatically translated into binary coded decimal form and punched into tape, ready for use by the control system.

▶ Control Details

A simplified block diagram of the electronic control unit for a machine is shown in *Fig* 4. Inputs to this unit include auxiliary function commands, dimensional data in the form of desired positions with any modifications, and actual positional data from the feedback circuits mounted on the machine tool. The diagram also shows another input labeled

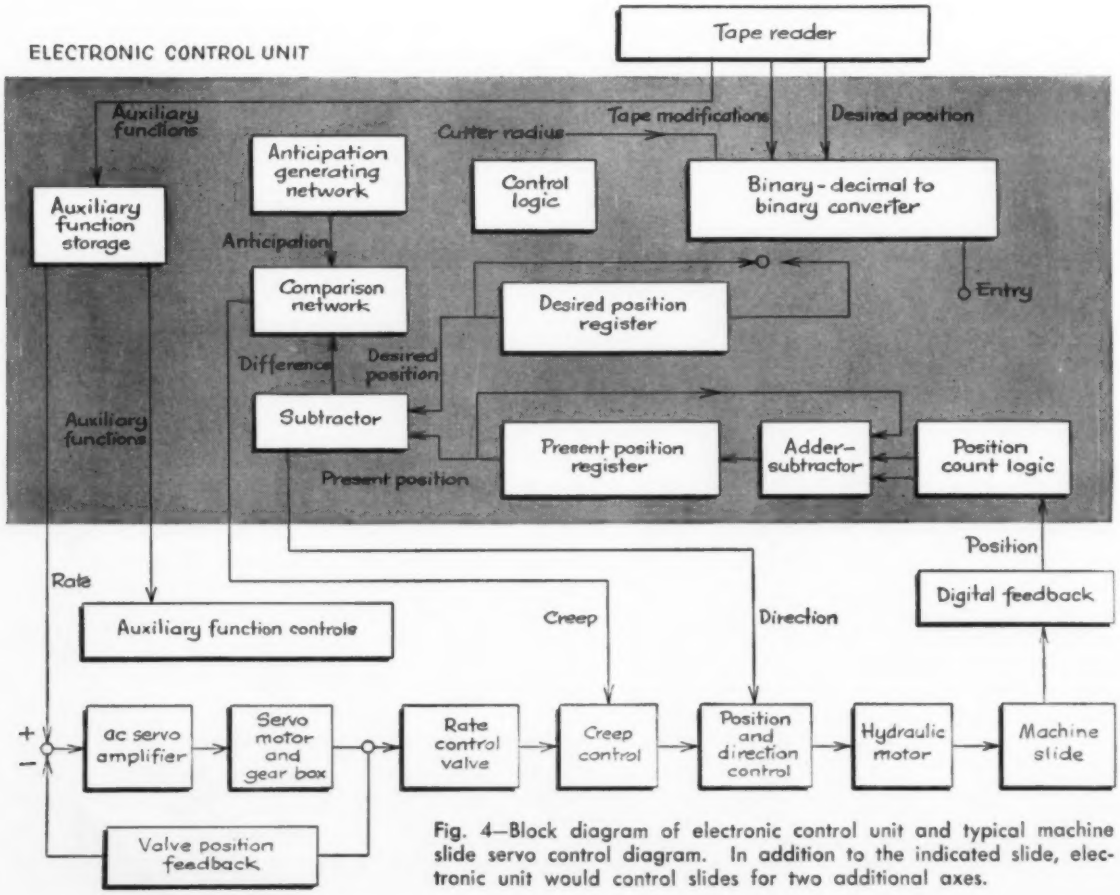


Fig. 4—Block diagram of electronic control unit and typical machine slide servo control diagram. In addition to the indicated slide, electronic unit would control slides for two additional axes.

Fig. 5—Auxiliary control feature permits adjustment of dimensional information going into electronic control unit. It is possible to compensate for tool wear, without repunching control tape.

"cutter radius." This is an auxiliary feature that permits the operator to manually adjust the control dimensions of the boring tool. During preparation of the punched tape, the planner would specify a nominal diameter, not knowing the detail settings or condition of the cutter in the machine. In the setup operations, the machine operator would determine the necessary details and adjust the dimensional information by manipulating appropriate switches on the console of the electronic compensator, *Fig.* 5. It is possible to compensate for tool wear in a similar manner without the need for repunching tape.

Within the electronic control unit, information is received from the tape and adjusting switches in binary coded decimal form and converted to pure binary form notation. This desired-position information is then sent to a circulating register. Feedback information representing present position is constantly being sent to a similar circulating register. These two quantities, desired and present position, are evaluated by a subtractor unit to determine the direction the servos must move to achieve a zero difference between desired and present positions. Other equipment in the control unit controls rate information, including provisions to slow down to a creep rate when the difference between desired and present positions is small.

It is of interest to note that the measuring system which determines the present position of slides is not dependent on lead screw accuracy. Heart of the technique used is a metal bar containing a series of finely etched lines—500 to the inch. Motion of a machine member is sensed by a small pickup head which reacts to the change in an electromagnetic field as the head passes over the etched lines on the bar, providing a means of counting for the purpose of control. Accuracy of control in positioning is to within one thousandth of an inch.

Improved Models

Flexibility is the outstanding feature of both the machine tool and control equipment in this new line. This highly desirable quality applies not only to the equipment in action but also to the means by which components can be brought together to form other production lines.

As an example, any number of machine tools can be combined into any desired sequence. The sequence and content can be rearranged to suit different requirements. Each worktable of the prototype machines is capable of indexing a fixture to four positions, 90 degrees apart; the equipment will take care of any fixtured part that lies within a 12 x 12 x 8 inch parallelepiped. Within these limitations, maximum benefits will be obtained from the numerically controlled line if design of the workpieces calls for machining on only the four surfaces which are presented to the machine tool by the indexing action. Thus, it is both possible and feasible that all machining operations on certain parts can be completed while the part is in one holding fixture. Examples of the wide range of parts which can be produced

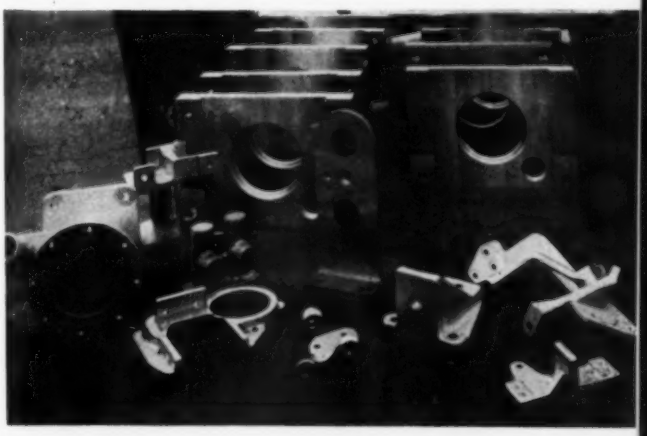


Fig. 6—Wide variety of parts can be machined on numerically controlled line. Prototype machine is capable of handling parts which lie within a 12 x 12 x 8 inch parallelepiped.

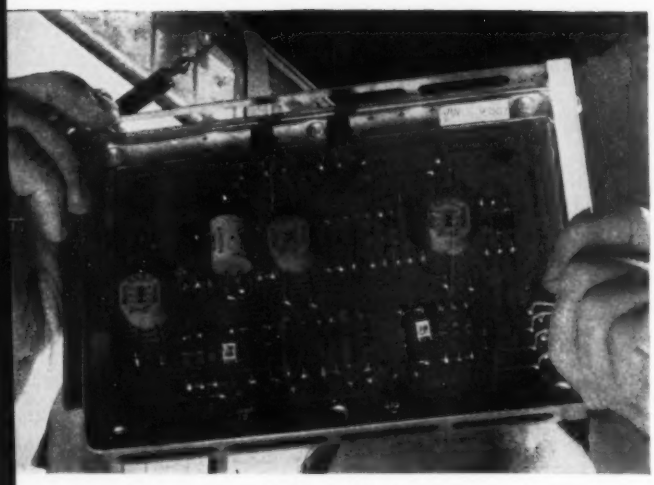


Fig. 7—Basic building blocks for control circuits are constructed in this "insert" form. Use of printed circuits, transistors, and diodes saves space and improves reliability.

are shown in *Fig.* 6.

The standard line of equipment will differ from the prototype equipment in a number of respects. Parts within 18 x 18 x 12 inch limits will be handled; worktables will index to eight positions, 45 degrees apart. To obtain increased machine utilization, transfer of fixtures between machines will be random rather than simultaneous. Balance will be obtained by providing for banking between machines.

The standard horizontal milling machine will be similar to the prototype model, capable of feed movements along 3 axes. In addition, a profile mill will be available for use in a numerically controlled line.

The prototype drilling machine has a large 20-station turret that contains drills, reamers, taps, etc. Selection of tool is by commands from the punched tape. Each of the 20 tools has its own drill bushing, which is extended when the tool is extended. This eliminates the need for separate drill boxes or plates for different parts and permits accurate drilling of a piece held by the work fixture. To insure accurate thread cutting, each tapping spindle has its own lead screw. The standard production model will have only one spindle and it will be provided with a mechanism to change tools from a magazine that will hold a variety of 30 tools, including various size drills, taps, boring tools, and milling cutters.

The demonstrated boring machine has two spindles to provide for a range of boring operations. As has been stated, the boring bars are set to the proper dimension automatically from taped signals or the cutter adjusting switches. On the production model, the boring machine will have one electronically adjustable spindle. It will provide for facing, backfacing, and recessing cuts.

The building block design makes it possible to join milling, drilling, and boring operations to effect continuous machining of a wide variety of workpieces. This same concept of "building blocks" has been applied to the design of the electronic control system.

▶ Versatile Electronic Components

Nineteen inserts, or elementary building blocks, are used to build up all of the control circuits required. These inserts, *Fig.* 7, have been developed specifically for industrial applications, stressing reliability and low cost. Packaged into groups, inserts provide a means of forming larger functional building blocks. The functional building blocks are combined to form the control units, *Fig.* 8.

This approach to the manufacture of control systems has a number of distinct advantages: 1. Control units may be ordered with varying degrees of capability. 2. Some minimum amount can be purchased initially and embellished at a later date with supplemental control units. 3. Higher production rates obtainable with limited variations of components results in lower cost, higher quality, and improved reliability. 4. Multiple usage justifies more engineering effort in developing highly reliable, low-cost building blocks. 5. Multiple usage provides more justification for a cost reduction and state-of-the-art improvement program. 6. Wider usage provides field experience more quickly to guide product improvement programs. 7. Individual inserts should have a maximum re-use potential when improvements are warranted.

This rather impressive list of advantages is not solely based on the application of these inserts to the machine tool control field. As shown in *Fig.* 8, it is envisioned that a wide variety of industrial uses can be found for the elementary blocks, primarily to build up digital computers for general and

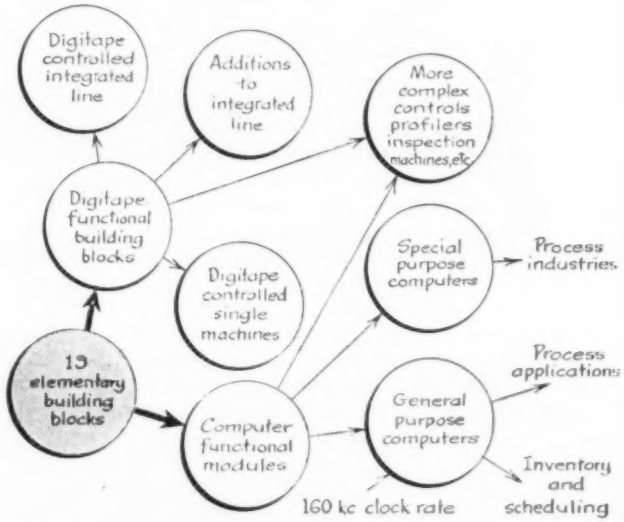
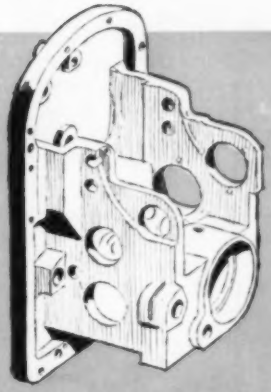


Fig. 8—Nineteen elementary building blocks can be combined to form the range of control and computer devices indicated. Numerous user benefits are realized from this functional approach to control manufacture.

special purpose applications.

In this age when producers must move towards better methods, tooling, and techniques much faster than in the past, the versatility of the numerically controlled transfer line will assume added importance. More and more frequently, production lines must be altered and adapted to improvements and changed specifications. In its most exaggerated form, this need for rapid changes is most evident in the aircraft and missile fields but certainly most job shop operations in all industries have the same need.



IS IT ECONOMICALLY FEASIBLE?

WHEN compared to conventional machining methods, numerically controlled lines promise significant savings in many cost areas. The advantage of numerically controlled lines increases in proportion to the extent that production requirements approach the purely job-shop category. Important savings in direct labor are obviously realized. Reduced tooling requirements benefit both cost and lead time (tooling parts can be machined on the numerically controlled line). In-line transfer eliminates much materials handling normally found in job-shops. Finished inventory requirements are significantly reduced when machining operations can be stored on tapes. Inspection and quality control functions are simplified. Perhaps most significant to certain industries, the overall lead time from design to part production is radically reduced.

Economic justification for a Digitape numerically controlled line is reviewed in the accompanying chart and graphs. The sample part is a speed gear box designed for a Kearney & Trecker milling machine. Company experience with the part has established the data listed under "Present Methods." These data are compared to a production method involving a 5-machine numerically controlled line. In the chart, probable flow time for the numerically controlled line reflects the assumption that the line would most likely be producing a variety of parts simultaneously.

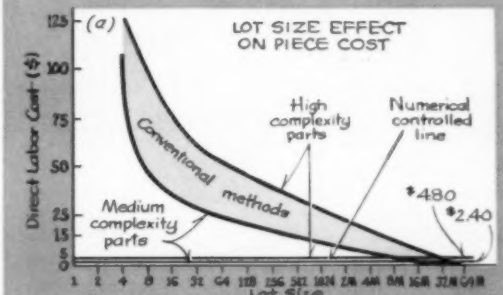
Graph (*a*) compares the effect of lot size on direct labor cost for a range of conventional production methods. It also shows a similar cost band for a numerically controlled line in which lot size is immaterial. This comparison of the two cost bands indicates that the numerically controlled line shows a cost advantage for production requirements below approximately 50,000 to 60,000 parts. Above this figure, the conventional transfer line is economically justified.

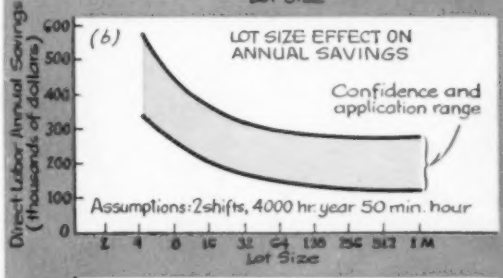
Graph (*b*) takes the savings between the conventional methods and numerically controlled line indicated by Graph (*a*) and extends these figures for a yearly period. It is assumed that for lot sizes ranging from approximately 128 up to the transfer machine justification point, savings would tend to level out primarily because of the problem of loading and unloading parts where separate machine tools are involved.

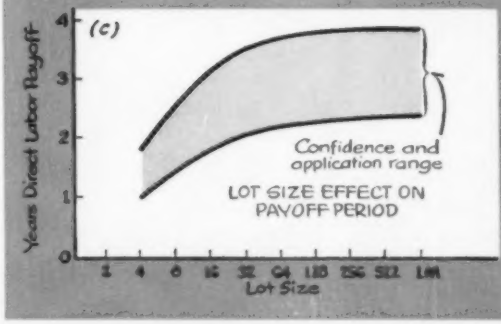
Graph (c) compares the savings for various lot sizes against the estimated selling price of a numerically controlled line. It should be noted that these figures deal only with direct labor savings and do not include other cost advantages which have been referred to.

One of the most unfortunate, erroneous beliefs that has arisen in the literature on automation is that it is a philosophy that is useful only to large-quantity producers. The concepts expressed in this analysis should help considerably to correct this mistaken belief. For, as is pointed out, there is a form of automation peculiarly applicable to typical job-shop requirements.

SPEED GEAR BOX No 38663	Present Method (22 machines)	N C Line (5 machines)
Setup hours	40.96	0
Machining cycle (hours each)	8.87	0.7
Probable flow time per lot of 10	16 weeks	2⅓ days
Economical lot size	10	Any
Tooling cost Fixtures Special boring heads	$6617 $18,000	$1847 0
If line was continually producing similar parts work in process inventory reduction		$149,800
Floor space reduction For machines For inventory		30% 90%

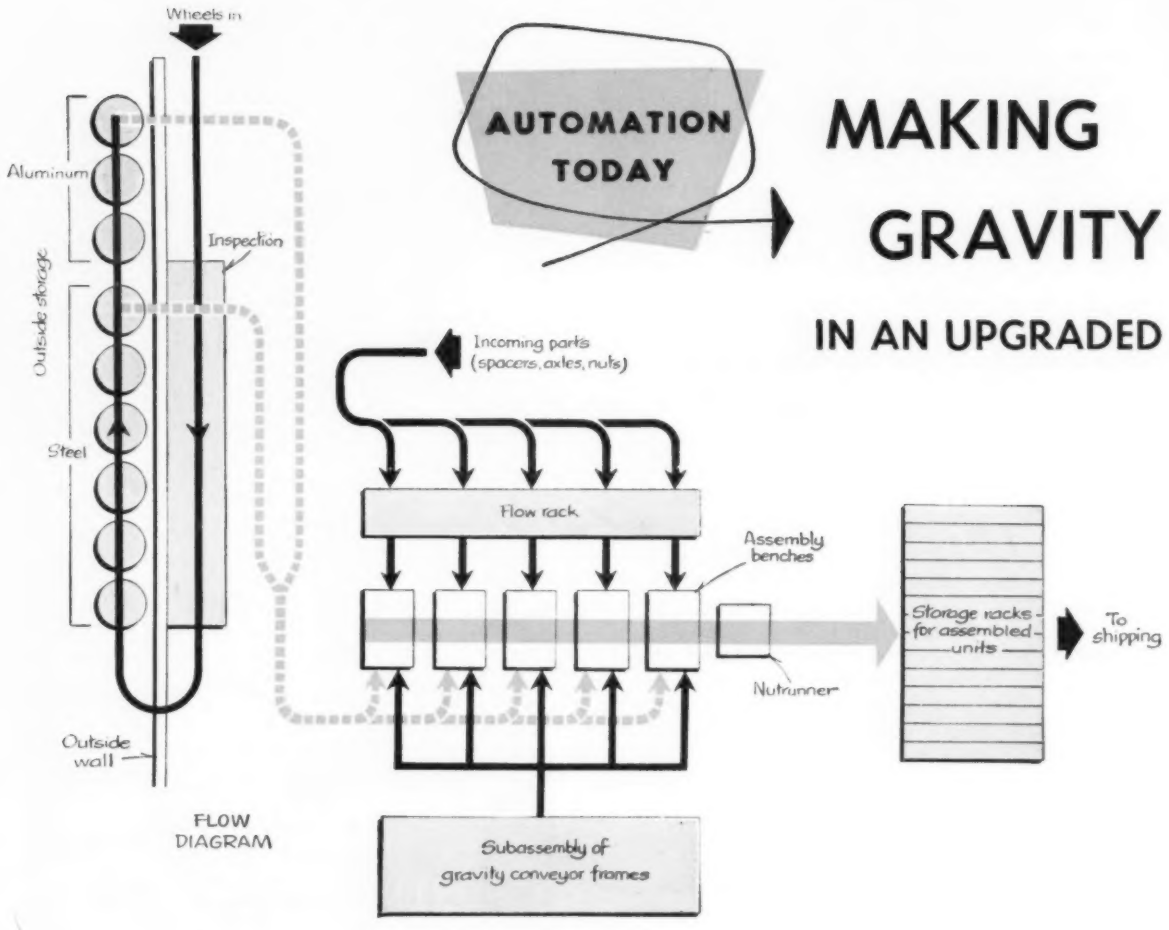



(b)
LOT SIZE EFFECT ON ANNUAL SAVINGS
Direct Labor Annual Savings (thousands of dollars)
Confidence and application range
Assumptions: 2 shifts, 4000 hr. year 50 min. hour
Lot Size



AUTOMATION TODAY

MAKING GRAVITY IN AN UPGRADED



AUTOMATION involves three key phases of manufacturing operations — the processing steps or equipment, the handling systems or devices, and the automatic control arrangement. Of these three phases, materials handling is present to some degree in every problem area of management. Although some management functions, such as accounting or purchasing, may appear to be far removed from actual contact with handling problems, nevertheless they can be influenced to a significant degree by the efficient use of this phase of automation. This being the case, it becomes the first order of importance that all management arts be co-ordinated into a close-working team when large-scale handling projects are being planned and executed. The Rapids-Standard Co. Inc. calls this principle "get everyone in the act" and demonstrated its effectiveness during a recent plant expansion program.

Over eight years ago Rapistan built a modern, one-floor plant in Grand Rapids and equipped it with new automatic machinery and tools. Many operations that were formerly housed in a crowded, multistory building were moved to the new plant. In spite of the large capital investment in plant, machines, and tools, the company ended up with higher costs and lower profits. The company learned through experience that added space could lead to added cost and decreased efficiency—just more mileage for men and materials to travel in converting raw materials to finished product.

Several years ago the company was faced with a growing need for more manufacturing space in order to increase production. Preliminary plans were developed for a $300,000 expansion in plant and equipment to provide the additional capacity. Aware of the problems encountered in the last large expansion, management appointed a committee to investigate the proposed capital investment to see if it could be reduced by improvements in its existing plant. Members of the engineering and the production departments thought it possible to obtain higher efficiency and more effective space utilization through extensive use of modern handling techniques.

A thorough study of over-all company operations was made. One important factor noted was that changing customer needs and increased production requirements had obsoleted once-efficient handling methods as being too slow and costly. A broad improvement program was started under the co-ordination of the manufacturing vice president with full

CONVEYORS

MANUFACTURING PLANT

responsibility for determining the economic justification of increasing productivity by installing new methods and new handling equipment. Rapistan called this program the "Technics" approach to plant improvement—co-ordinating all the management arts through the medium of materials handling for greater productivity and profit. Many accepted principles of handling were applied through this program and new ones were created and proved as the program progressed.

As the technics program evolved, it became apparent that every phase of plant operation—in fact, every phase of business management—was involved in or affected by changes in materials handling methods. The new plan reached into many areas of management not directly responsible for plant operation. Handling improvements in one department led to changes in another; and these changes, in turn, affected other departments. The changes involved not only materials handling, but procedure, methods, accounting, and even policy.

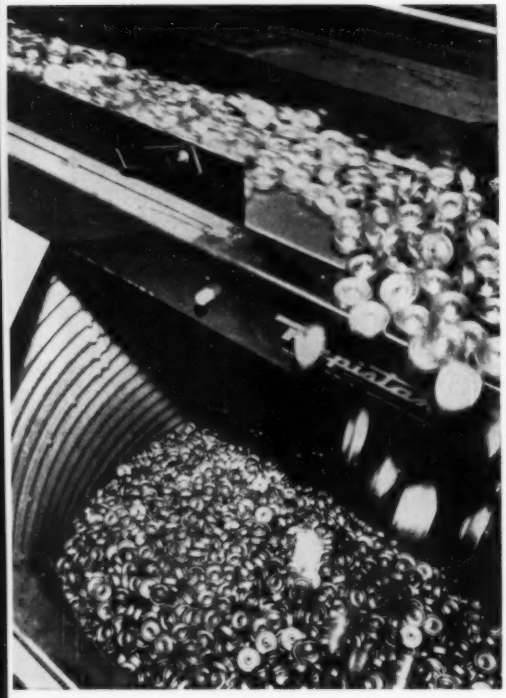
The rearrangement of facilities in the Rapistan plant began in the plant layout department. Plant departments and operations were laid out so that straight line flow was followed throughout the entire plant from receipt of raw materials to shipment of the finished product. One direct result of this flow pattern—and a big factor in reducing operating costs—was that flow lines were appreciably shortened. In many areas of the plant, flow lines are now so short that materials move from operation to operation without using intermediate handling means. This eliminates the cost of intermediate handling and the time involved in waiting for men and equipment to move materials.

The program revealed that a large percentage of the long distance hauling within the plant resulted from moving materials from a central storage area to the point of use. Study showed that many items kept in central storage could be stored at the point of use immediately upon receipt. This led to the very extensive exploitation of "positioned inventory" at the point of use. By applying this concept, the central storage area was reduced. A byproduct of this development was that it allowed a reduction in the total amount of inventory required. With a higher rate of turnover, a smaller investment in raw materials is required which in turn favorably affects the financial position of the company.

Positioned inventory at the point of use led to a new development in plant layout and operation—perimeter feed. Many production areas were rearranged so that they are completely surrounded by service aisles and live storage racks—a form of storage conveyor in which materials rest on roller, wheel, or powered conveyor within a structural framework to form a series of tiered storage compartments. Raw materials are loaded into the live storage racks from the service aisles and workers within the confined production area remove material from the racks as required. Finished work is then loaded into other racks for transmittal to the next production operation. Since this method of operation re-

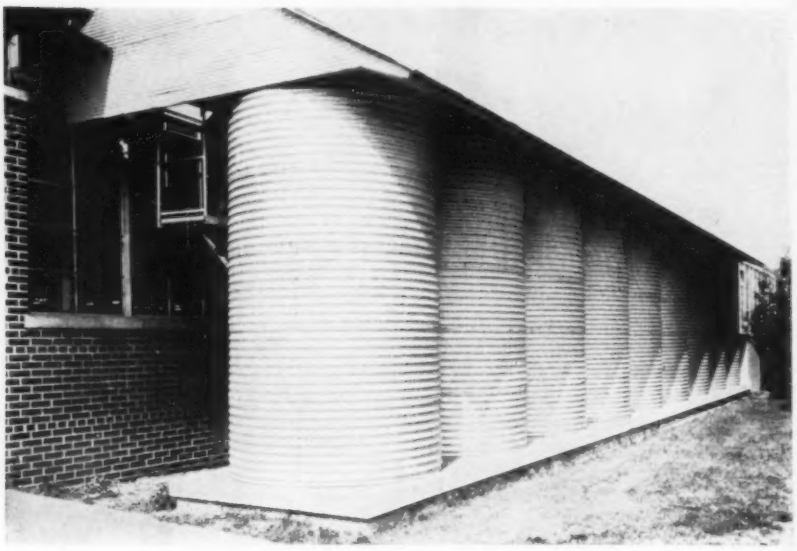
1

Millions of wheels used in the manufacture of gravity conveyors by Rapids-Standard Co. Inc. are handled from receipt to point of use by conveyors. Incoming aluminum and steel wheels are dumped from burlap bags into the hopper of a cleated belt conveyor. Quality control conducts visual inspection as wheels are received and selects representative samples for physical tests.



2

Conveyors carry wheels across top of nine silos located outside of plant wall. Silos are filled individually by diverters across the belt conveyor. When one silo is filled, diverter is changed to load wheels in other silos.



3

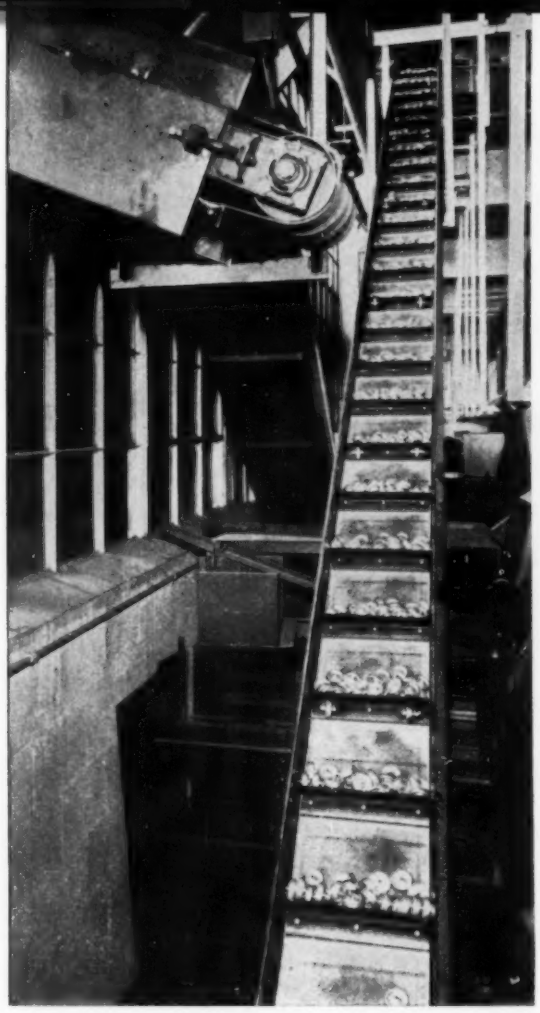
Location of the nine silos outside the plant wall saves valuable manufacturing space and removes a noisy operation from working areas. Each silo will hold an average truckload of 100,000 wheels. Six of the silos are used for steel wheels and three for aluminum. If quality control finds a faulty shipment, entire silo can be immediately emptied for shipment back to the supplier.

quires little or no materials handling within production areas, considerable space normally used for intradepartmental aisles is saved and the entire enclosed space devoted to production.

Throughout the plant the principle of live storage in racks made effective use of storage floor space. In the die maintenance area an inventory of 165 dies, weighing from 200 to 800 pounds each, are

4

Wheels are released from the bottom of the silos by controlled chutes and are carried by powered conveyor belts to the point of use. Separate conveying systems are provided for steel and aluminum wheels. Prior to the installation of the silos, bagged wheels were stored in a central storage area. In addition to being difficult to stack and wasting valuable manufacturing space, bagged wheels required considerable intermediate manual handling between receipt and actual use in product.



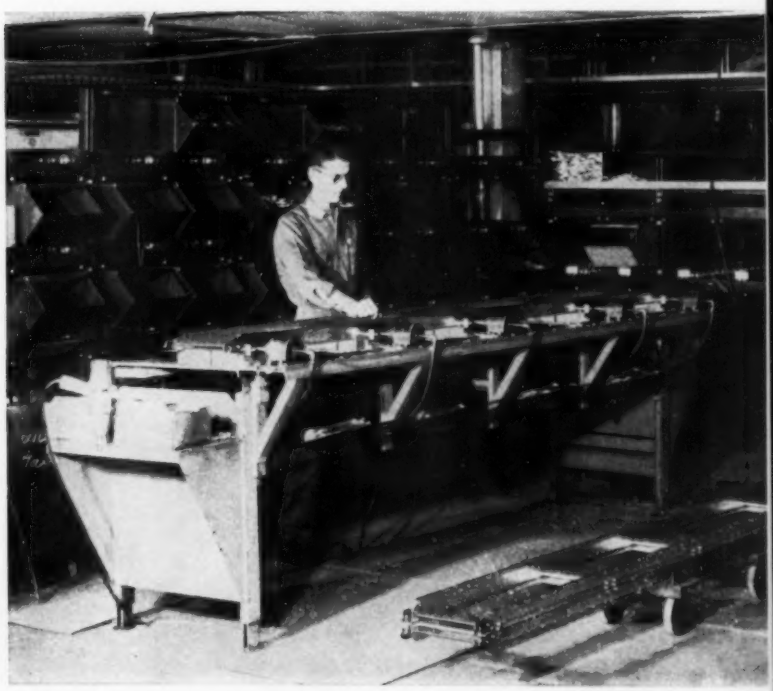
5 Cleated conveyor belt lifts wheels from bottom silo level to an overhead distribution conveyor. From there, wheels are conveyed to a manufacturing area where they are distributed to various assembly stations. Wheel storage and supply system makes full use of "air rights" as well as low-cost outdoor storage areas.

now stored in vertical racks reducing required floor space from 285 to 85 sq ft. In the receiving department, the entire inventory of electric motors for powered conveyors is stored on thin steel pallets in four-tier racks. As many as 1800 motors are stored in this manner in less than 725 sq ft of floor space. In the shipping department accumulated orders were removed from four-wheel dollies and stored in three-level racks.

Where materials had to be moved relatively long distances, overhead conveyors and fork trucks were put to use. Conveyors are used for constant flow items such as the gravity conveyor wheels shown in the accompanying illustrations and fork trucks are used for intermittent flow items. Each plant area is arranged so that it can be serviced by fork trucks from one or more wide service aisles.

Utilizing the ceiling space of the plant, the plant engineers installed a number of overhead conveyor systems to store hard-to-stack items such as jigs, fixtures, and irregularly shaped finished products. Each conveyor will run in either direction in order to save time of the operator waiting to load or unload material. It is now possible to store a great number of gravity conveyor sections and accessories by overhead conveyor and this factor enables the sales force to offer fast delivery on standard items.

Last, but not least, a study of paper work within the plant disclosed a multiplicity and duplication of requisitions, work orders, and material movement orders. A simple solution was developed. A mechanical tabulating card used for recording labor costs was adapted to serve several purposes. The same card, employing additional holes, colors, and information serves the multiple purpose of production scheduling, material movement tickets, work



6 While conveyor wheels are being transported to the assembly area, gravity conveyor frames are being assembled in another area. Live storage racks are used on two sides of the operator to hold parts used in the assembly operation.

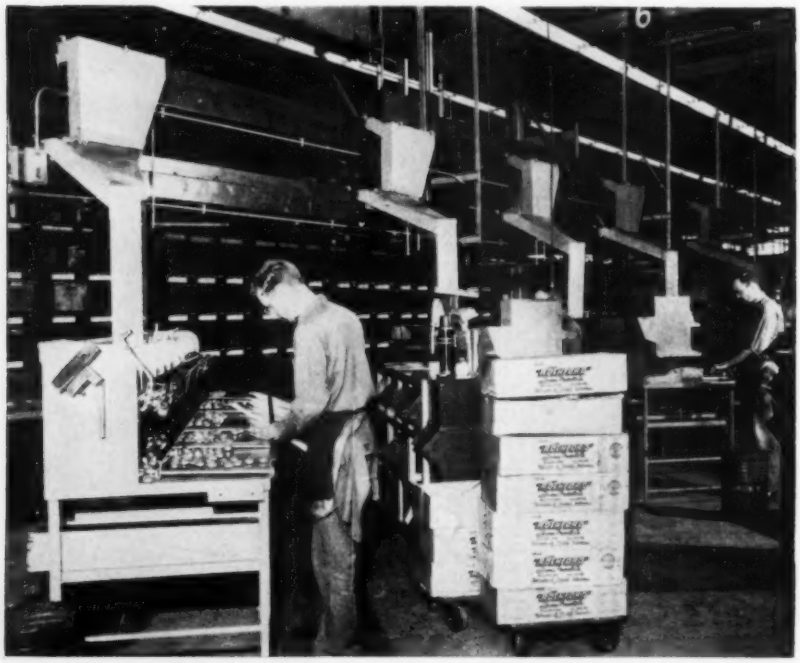
7

Incoming parts such as wheel spacers, axles, and nuts are stored in flow racks separating the traffic aisle from the assembly area. On the aisle side an operator moves tote boxes of parts into the rack. Each live rack in inclined toward the assembly area. As parts are required, the assembler removes the tote boxes from the other side of the rack and carries them to his assembly station.

standard reports, cost reports, setup reports, materials handling controls, and expediting control.

The results of the technics program were far greater than expected. By applying sound materials handling principles—and by developing some new ones—Rapistan was able to gain over 40,000 sq ft of additional manufacturing space from a total plant floor area of 120,000 sq ft. By spending $100,000 for materials handling equipment to effectively utilize wasted space in the plant, the productive capacity of the plant was increased a full 50 per cent and obviated the need for the proposed $300,000 new plant expansion. Due to more efficient storage and movement of raw materials and materials in process, total inventory is maintained at lower levels with a saving of $100,000 in inventory investment.

The program also bore fruit in the shipping department of the plant. Space saved by using live



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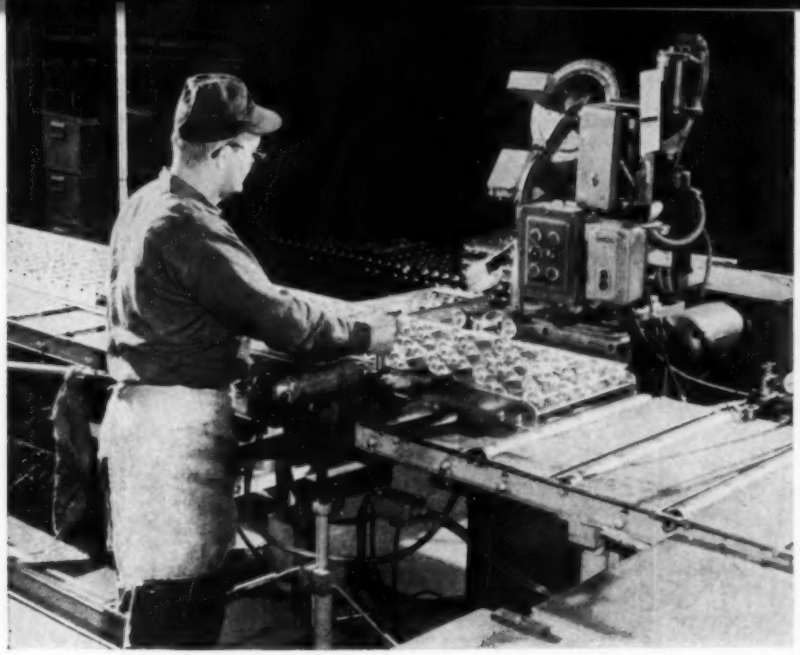
Inside the assembly area, parts are easily accessible to all operators. Steel and aluminum wheels are supplied to each station from the two overhead conveyors. In the background, within walking distance of each operator, is the flow rack containing tote pans of spacers, axles, and nuts. The assembly operator inserts the axles into the conveyor frame, adds wheels and spacers, and sends the unit to a nutrunner operation via the conveyor in front of flow rack.



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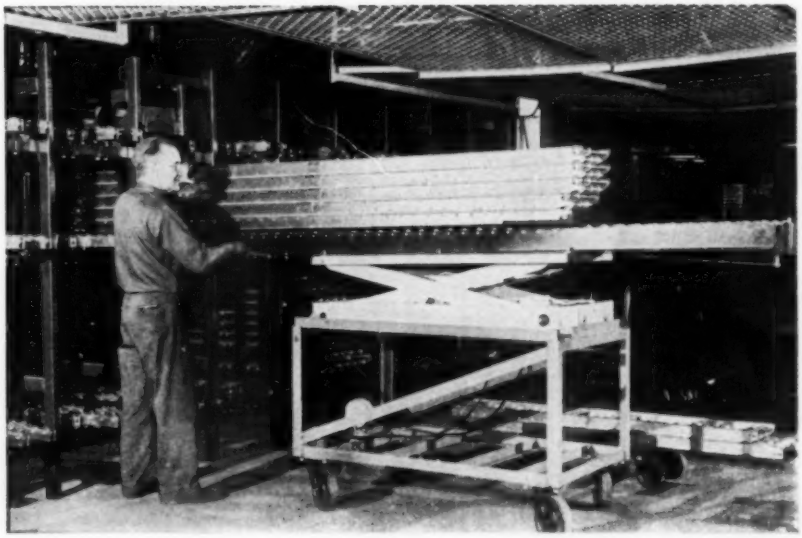
Assembled conveyor sections move past the nutrunner station on roller conveyor. Nut is fed from motorized hopper opposite operator and is positioned on end of wheel shaft. Operator applies power tool to opposite end of shaft to tighten nut. Finished section then moves direct to storage in a flow rack.



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Finished straight sections are stored in live roller flow racks. Elevator dolly is used to move completed units from the nutrunner station to storage in the upper tier of the flow rack. Small dolly to rear of elevator unit is used to transfer sections into lower tier of rack.

storage racks and overhead conveyors enabled the company to store three times as much finished goods as previously in less space. By maintaining a large stock of many different kinds of conveyor sections and accessories, Rapistan can deliver products with less lead time than is generally required in the industry. This has been a significant factor in increased sales.

Many intangible benefits resulted from the program. Improvement in workers morale, improvement in quality, and improvement in housekeeping can be seen but cannot be measured in dollars. Within departments, setup time for many operations was reduced by improved handling and storing methods. This made it possible to schedule smaller runs of many subassemblies and reduced the amount of storage required to accumulate parts for final assembly. Work standards were improved since reduced manual handling and easy accessibility of tools and parts resulted in more efficient use of manpower.

These are only a few examples of how the technics approach to plant improvement reached beyond the moving of goods through a production shop. Every department of management was affected by and contributed to the application of the concept for increased efficiency and cost reductions.

The accompanying illustrations cover only a segment of the over-all improvement program at the Rapids-Standard plant. They show the techniques in handling conveyor wheels from receipt to installation in the gravity conveyor sections. Basic concepts discussed in this article are evident in various parts of this production process.

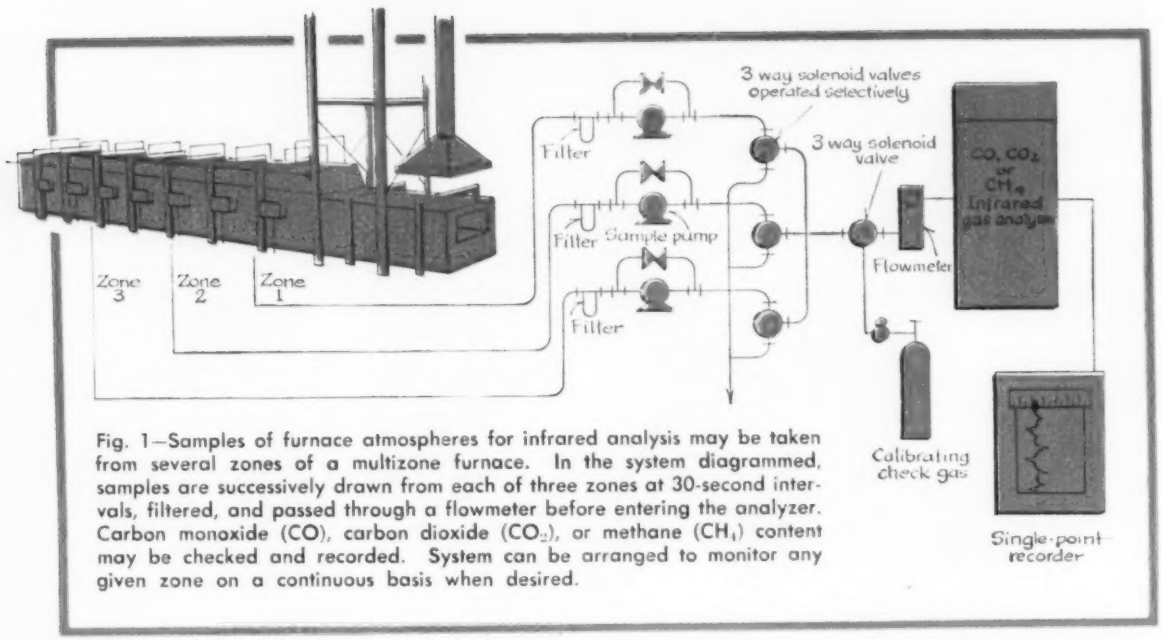


Fig. 1—Samples of furnace atmospheres for infrared analysis may be taken from several zones of a multizone furnace. In the system diagrammed, samples are successively drawn from each of three zones at 30-second intervals, filtered, and passed through a flowmeter before entering the analyzer. Carbon monoxide (CO), carbon dioxide (CO_2), or methane (CH_4) content may be checked and recorded. System can be arranged to monitor any given zone on a continuous basis when desired.

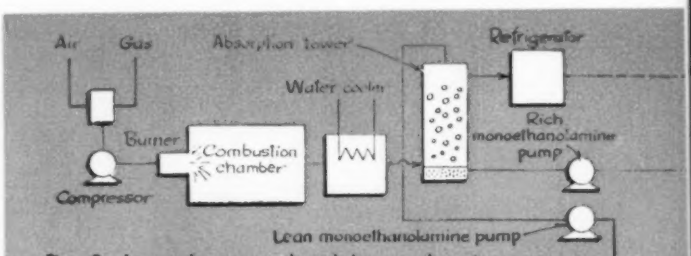


Fig. 2—Atmospheres produced by exothermic generators are essentially combinations of hydrogen (H), carbon monoxide (CO), nitrogen (N), carbon dioxide (CO_2), and water vapor. Generally, the CO_2 and water vapor are removed to provide a high-nitrogen reducing atmosphere. CO_2 is removed in an absorption tower or scrubber through which a solution of monoethanolamine is circulated. After the scrubbed gases have been refrigerated and dried to remove water vapor, atmosphere samples are taken and the CO or CO_2 content is analyzed and recorded.

APPLYING INFRARED ANALYZERS TO CONTROL FURNACE ATMOSPHERES

By J. L. GARRISON,
Application Engineer, Heat Treat & Metalworking Div., Leeds & Northrup Co., Philadelphia, Pa.

CONTINUOUS monitoring of heat treating atmospheres through use of infrared analyzers and recorders is a key means of attaining uniform, predictable results in the production annealing, hardening, and carburizing of steel parts. Data so obtained provide a permanent record of conditions during a run, assist operators in reproducing these conditions in subsequent runs, and facilitate rapid changeover to different compositions when required.

Control of the composition of an atmosphere in a heat treating furnace is important in order to avoid excessive scaling and provide a good surface on the work. Atmospheres are normally produced in generators that are external to the furnace. Two basic types of generators—exothermic and endothermic—are commonly used in industry.

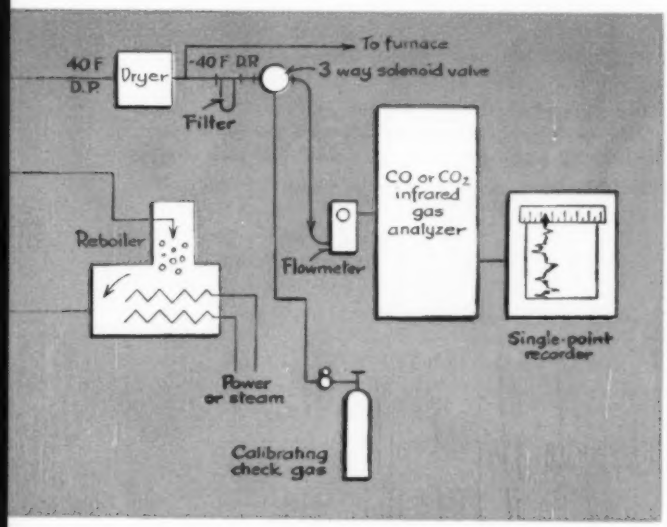
Exothermic generators produce furnace atmospheres by the burning of gaseous fuels in combination with air. Fuel/air ratios are regulated to establish desired compositions. Relatively inexpensive fuels such as propane, butane, natural, or manufactured gas are used. Endothermic generators differ from exothermic in that they produce atmospheres through the reaction of air/gas mixtures at

high temperatures. External heat must be added to effect this reaction.

Of the two types of atmosphere generators, the exothermic generator is suitable for the greater number of industrial installations. This is largely due to the simplicity of its construction and its adaptability to a wide range of operating conditions.

Points of Measurement

The carbon level of a heat treating atmosphere can be deduced by measuring its carbon monoxide (CO), carbon dioxide (CO_2), or methane (CH_4) content. When the composition and flow of gases to the atmosphere generator are constant, atmosphere samples may be taken directly from the furnace, *Fig.* 1. In this case, when the process calls for periodic changes in air/gas ratios, CO or CO_2 monitoring permits rapid measurement and translation of results into control adjustments by an operator.



When the composition of the gas supply tends to vary due to instability or changes of supply, as might occur during peak load periods, other sampling points are preferred. These may be at the dryer output of an exothermic generator, *Fig.* 2. or at the exit from an endothermic generator, *Fig.* 3.

Atmosphere Monitoring Applied

At a midwestern wire mill, *Fig.* 4, continuous furnace atmosphere monitoring has been applied to an annealing operation. The plant manufactures wire in sizes up to ¾ inch in diameter, in at least a dozen grades of steel including SAE 1010 and 52100. Coils range in size from 10 to 36 inches ID. Because of the wide range of sizes and material compositions handled, the makeup of the protective atmosphere is critical. A reducing atmosphere, produced by an endothermic generator, prevents oxidation and decarburization of the wire.

To monitor this atmosphere, a Leeds & Northrup Co. infrared analyzer with a range of 0 to 3 per cent CO_2 is used. The analyzer cell assembly and calibrating accessories are mounted adjacent to the furnace. A continuous recorder is located in a central control room.

Because the exact composition of the atmosphere is known at all times, the quality of annealing is consistently high. Coils received from the furnace have clean surfaces, and their properties are well within heat treating specifications.

How Infrared Works

The industrial infrared analyzer includes two basic components: 1. An analyzer cell, which is usually located at or near the furnace. 2. A recorder, which can be mounted either at the furnace or remotely, as in a central control room. Measurement is based on the fact that different

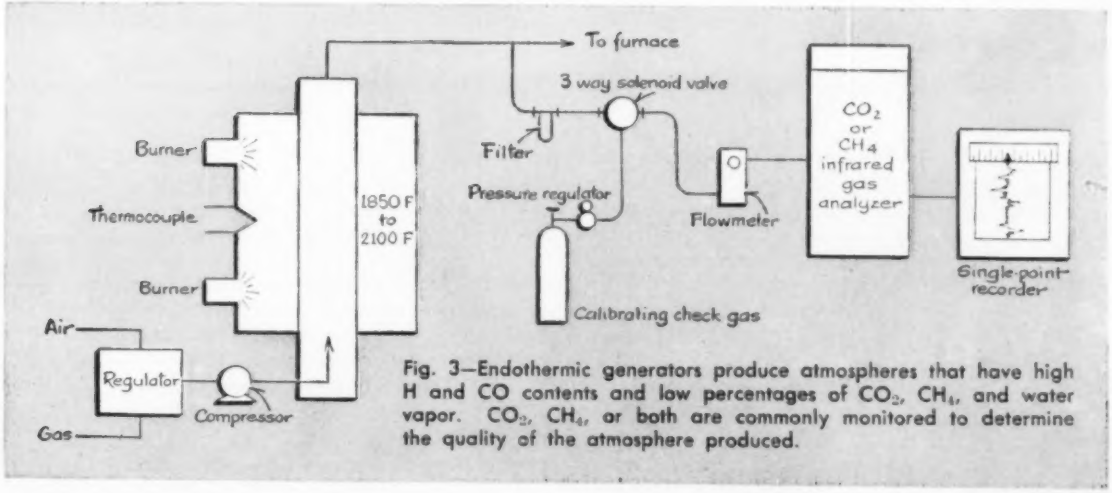


Fig. 3—Endothermic generators produce atmospheres that have high H and CO contents and low percentages of CO_2, CH_4, and water vapor. CO_2, CH_4, or both are commonly monitored to determine the quality of the atmosphere produced.

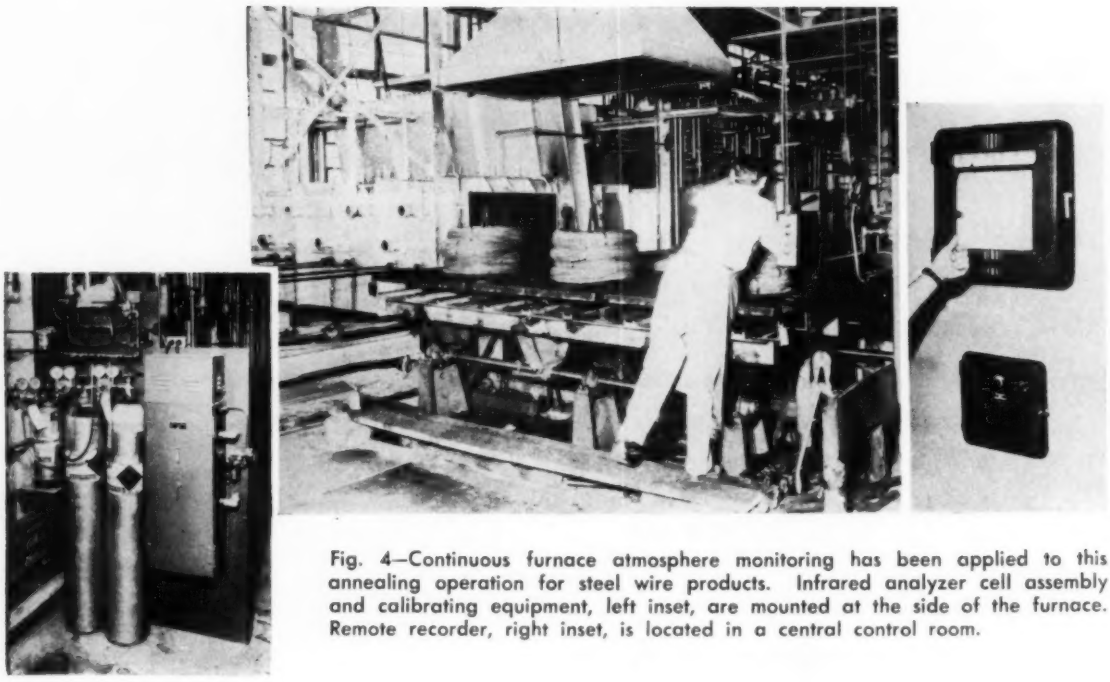


Fig. 4—Continuous furnace atmosphere monitoring has been applied to this annealing operation for steel wire products. Infrared analyzer cell assembly and calibrating equipment, left inset, are mounted at the side of the furnace. Remote recorder, right inset, is located in a central control room.

gas compounds in a mixture absorb radiation from different parts of the infrared spectrum. Thus, each compound can be identified on the basis of its infrared energy absorption.

Infrared radiation from a constant source is passed through a sample of the atmosphere to be measured and, at the same time, through a known reference gas. The radiation difference is detected by a thermopile which includes differentially connected thermocouples. Immunity to stray electrical pickup and mechanical vibration are necessary qualities of the thermopile. Changes in the emf output of the thermopile are measured and recorded on an instrument recorder. This recorder may be calibrated directly in per cent of the gas compound being measured in the sample cell.

Recorders are available which plot the percentage of a single gas sample, or of several samples of the same constituent on one chart. Scales may be graduated directly in per cent CO, CO_2, or CH_4. Alarms, signals, or remote indicators can be added. The recorder can also be equipped to operate any one of a number of types of automatic controls.

Lower operating costs, increased yields of good product, and more consistent machining properties are among the benefits obtainable through continuous monitoring of heat treating atmosphere quality. Of broader interest is the possibility of applying some of the same principles in other fields and in the manufacture of other products.

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SYSTEM STRAPS AND WEIGHS PAPER ROLLS

HANDLING of large rolls of paper has been speeded at a papermill in the Southeast by the installation of an automated binding and weighing system. Rolls are loaded on one end of a conveyor, transported through a binding machine which automatically applies a steel strap to each end of the rolls, conveyed past an automatic weighing and recording station, and automatically ejected from the other end of the conveyor by a turntable, *Fig.* 1 and 2.

In the finishing operations of the papermill, paper rolls are unloaded from the paper machine and are moved to the strapping conveyor. During this transfer, the rolls are stenciled, plugged with wood cores, and tailed. An operator loads the roll on the conveyor which is slightly below floor level. A stop on the other side of the conveyor prevents the roll from rolling beyond the conveyor. After the roll has settled on the conveyor, the operator presses the conveyor *Start* button.

The conveyor carries the roll into the strap chute of the binding machine. A limit switch automatically stops the roll in the correct position for the binding machine to apply a strap approximately $\frac{5}{8}$ inch back from the leading edge of the roll. As soon as the strap is sealed, the strap chute automatically refills and the conveyor moves the roll ahead until another limit switch causes the roll to stop in a position for applying the second end strap. After application of the second strap, the roll is automatically conveyed past an automatic weighing and recording station to an unloading turntable. When the roll has stopped on the turntable, the unit can be rotated toward the warehouse for storage or toward the loading docks for shipment.

The binding machine can handle up to 70 rolls per hour, depending upon the average diameter and length of rolls. Normally, roll diameters are between 32 and 60 inches. The complete binding, conveying, and ejecting operation is automatic once the *Start* button has been pressed. Powered conveyor for the installation was provided by Engineering Products Co., and the binding machine was supplied by Signode Steel Strapping Co.

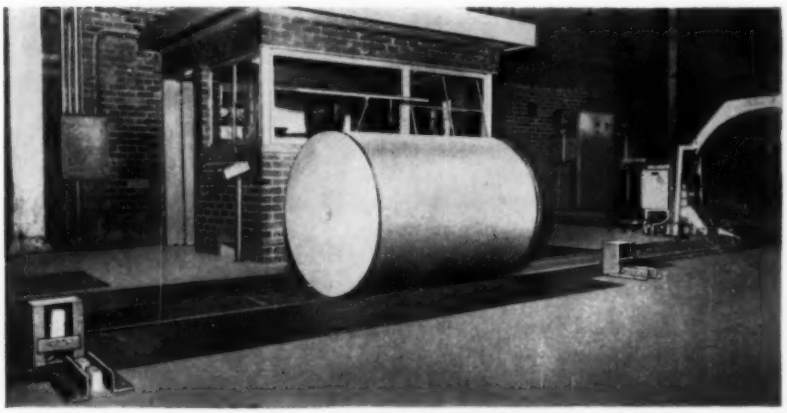


Fig. 1—Automatic binding machine on right applies steel strap to each end of paper roll at a papermill in the southeast. Roll then passes automatic weighing and recording station as conveyor carries roll to unloading turntable. Integrated binding and conveying operation is completely automatic after roll has been loaded onto starting end of the conveyor.

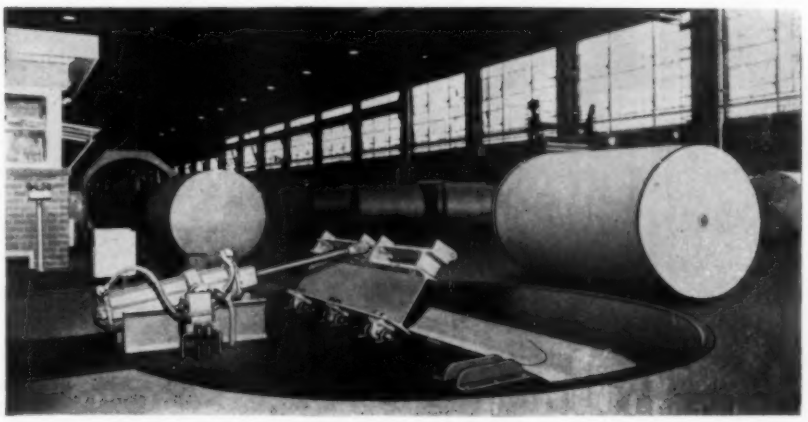


Fig. 2—End of the conveyor line for strapped rolls is the automatic ejecting unit. After a roll has stopped on turntable, unit can be rotated to aim roll toward warehouse storage or toward shipping dock.

INSTRUMENTATION APPLICATIONS OF MAGNETIC TAPE RECORDING

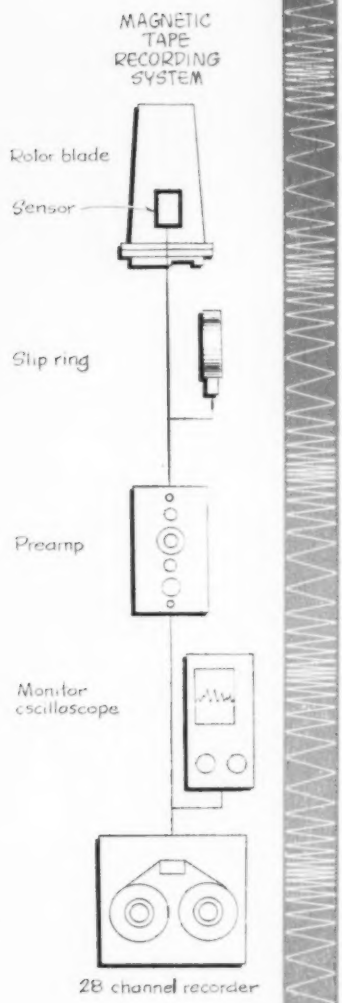
Building on the general description of recording techniques contained in an earlier article, the author focuses attention on the application of magnetic recording equipment to instrumentation problems. The value of tape systems lies in their ability to handle large quantities of data requiring rapid processing.

By PHILIP A. MOHR
Engineering Operations Section, AGT Div., General Electric Co., Evendale, Ohio

REQUIREMENTS of research and development work in the jet aircraft engine field have led to extensive use of magnetic tape recording equipment. However, the techniques which have evolved are not limited to specialized areas of application. Tape recording and playback equipment are merely tools which stand ready to be exploited by the resourceful.

"Magnetic Tape Systems for Data Recording," a complement to this article, has appeared in a previous issue of AUTOMATION.[1] The earlier article was devoted to a general description of magnetic recording and playback techniques, discussing four typical schemes of recording intelligence on magnetic tape—digital, frequency modulation carrier, pulse width modulation, and direct recording. Relationship of a record-

[1]References are tabulated at end of article.



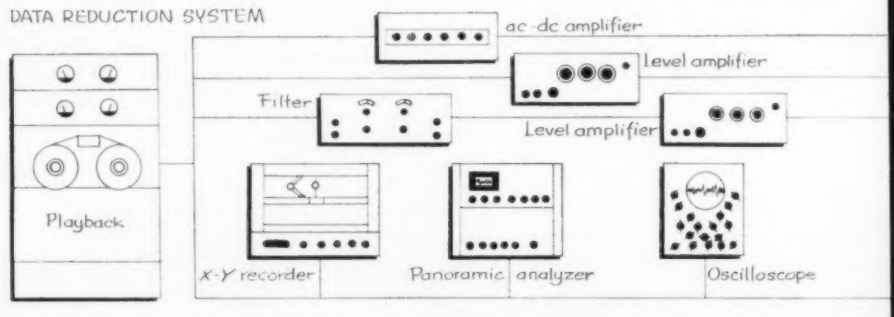


Fig. 1—Magnetic tape system as it might be applied to obtain data from vibration test. Playback system would provide results in several different forms.

ing system to a complete tape system is shown in *Fig.* 1. The recording equipment for such a system is shown in *Fig.* 2. It now remains to cover in more detail the methods of recording various functions which are typically encountered in development testing. The general scheme for sensing and recording a variety of functions is shown in *Fig.* 3. The diagram is not intended to be all-inclusive but merely illustrates some tried and proved devices applied as transducers.

Speed Recording

Rotational speed can be sensed by a tachometer-generator. Assuming the output of this transducer to be an ac voltage, a complete chain from the stimulus to a time history plot is shown in *Fig.* 4.

The system considers FM only, although other techniques will work just as well—in some cases better. The undesirable feature of the illustrated method of recording rpm is that the response of the system is limited by the frequency output of the ac tachometer-generator. For example, in jet engine applications the standard variety of ac tachometer, which normally positions a cockpit indicator is only around 70 cps at 100 per cent engine speed. Although it is a three-phase device, only one phase is used in this case to deviate the FM oscillator. As a consequence, a filter with fairly long time-constant must be used in the rectifier to avoid excessive ripple content in the output voltage of the rectifier-filter, particularly at low engine speeds. If the time-constant of the filter is too large, the indicated speed signal will lag the true speed signal. The result will be an error in the actual indication of the speed as presented on the track of the recorder over the rapidly varying portion of the speed transient.

The transient response of this rpm system may be improved in several ways. The first and least troublesome is to place the filter between the ac tachometer and the FM oscillator—at the same time converting the rectifier from a full-wave, single-phase type to one of a full-wave, three-phase type. In this way, the ripple frequency of rectification is

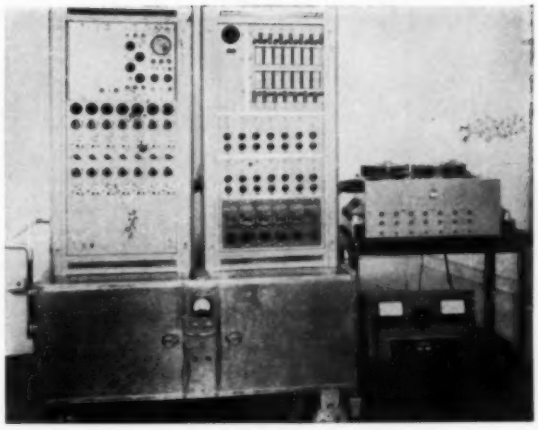
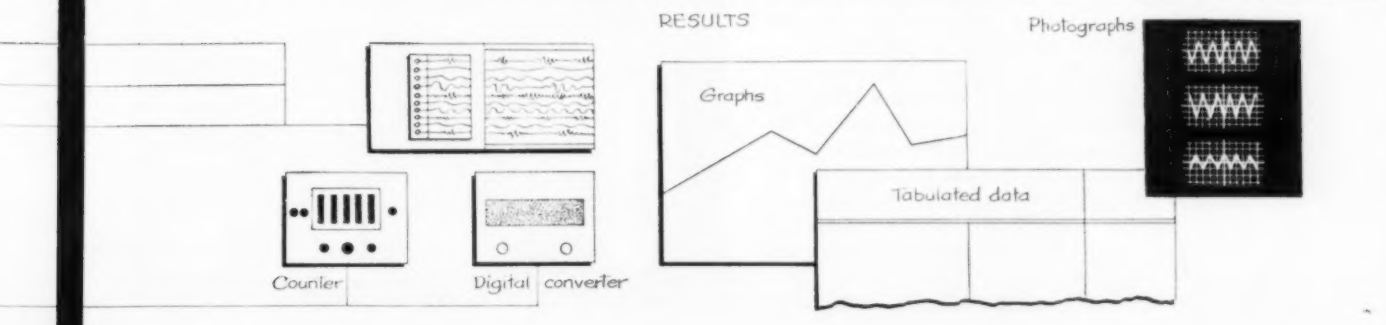


Fig. 2—Recording part of magnetic tape system shown in *Fig.* 1. Tape recorder is on wheeled table at right. Large cart contains such items as monitor oscilloscope, ac preamplifiers, dc preamplifiers, and calibration equipment.

increased three-fold, allowing a substantial reduction in the time-constant of the filter. The output of the data discriminator is then a dc analog of rpm which is fed directly to the direct-writing recorder. To improve the response beyond this requires replacement of the ac tachometer with a very high frequency unit or a fast-response dc unit.

Pressure Recording

There are a wide variety of methods of detecting and recording pressures. The most common method employs the principle of the Wheatstone bridge, *Fig.* 5. Physically, one or more legs of the bridge are active elements and in some way are connected to the pressure stimulus, P, through a diaphragm. In the example of *Fig.* 5 resistance in only one leg, A, is varied by the pressure stimulus, P. For zero pressure conditions, and balanced bridge conditions, the ratio of $A:B = C:D$ must be satisfied in which case the output signal is zero. If the bridge is not



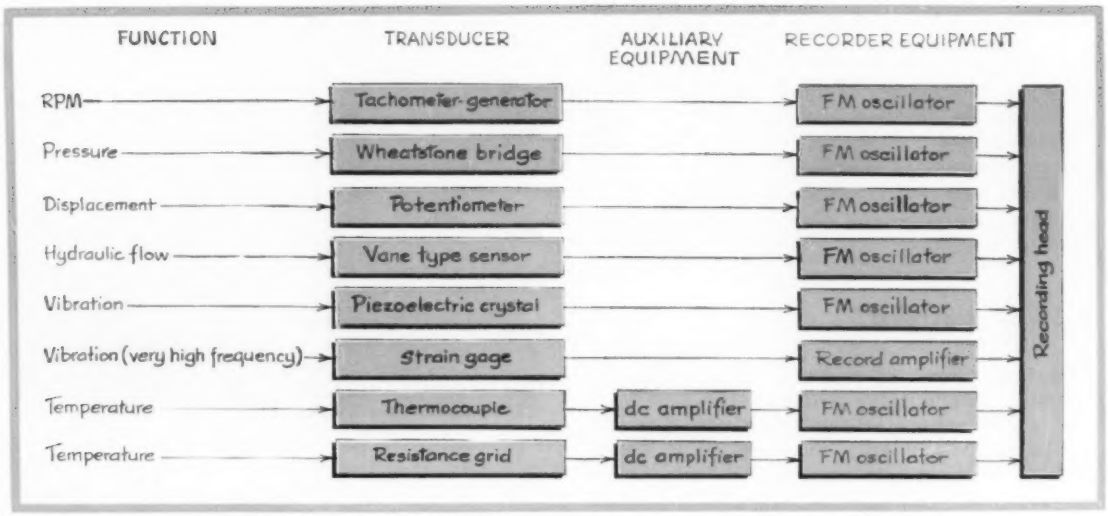


Fig. 3—Types of transducers typically used in magnetic tape recording system to record the indicated functions. FM oscillator shown in diagram is but one of available schemes in recording intelligence.

balanced at zero pressure input—due to manufacturing tolerances—balance is achieved through adjustment of the balancing pot. The purpose of the calibration switch is to shunt the active leg with a large resistance. In this way, an unbalance of the bridge is simulated. The amount of unbalance is compared against a dead-weight test calibration curve of the transducer. Thus, an equivalent pressure is established for a resistor. Therefore, before and after a test run, a new calibration curve can be re-established by sequentially shunting one leg of the bridge with resistors of known equivalent values of pressure. This affords a check on the validity of the data and discloses any variations in the excitation voltage.

The output of the bridge is sufficient to drive a high sensitivity galvanometer; thus, the output can be directly connected to a magnetic oscillograph through a suitable galvanometer damping circuit. In this case, the excitation voltage must be from a dc source. The use of high frequency response galvanometers usually requires the insertion of an amplifier between the transducer and the galvanometer.

There are several approaches to the application of a Wheatstone bridge pressure transducer to a magnetic tape system. From the standpoint of FM recording techniques, the bridge itself may be an integral part of an FM oscillator. Consequently, system complexity is minimized by eliminating the need for a special source of voltage excitation and ac or dc amplifiers between the transducer and recorder. In the event a voltage controlled FM oscillator is used, system complexity is just about the same as for the oscillograph installation. Suppressed-carrier amplitude modulation to FM is well adapted to bridge types of transducers.

The old-fashioned Bourdon tube is being used more frequently as a pressure detecting device since the advent of the tape recorder and FM recording techniques. The deflections of the tube control the air gap of a variable reluctance device. The inductive portion of the variable reluctance element or pickup is an integral part of an FM oscillator.

Potentiometers are often used in pressure transducers where the action of a bellows or diaphragm positions the wiper on the potentiometer card. This is a satisfactory device for recording relatively low frequency variations since the level of the output is sufficiently high so that auxiliary equipment in recording is not needed.

A relatively new transducer system has been introduced to the field of instrumentation that appears to be remarkably well adapted to FM recording of data on magnetic tape. This transducer system is shown in *Fig.* 6. The system incorporates a bridge of which the transducer is a part. Contained in the transducer is a fine wire under tension vibrating at its natural frequency. One end of the wire is attached to a pressure diaphragm. As the diaphragm expands or contracts, the natural frequency of the

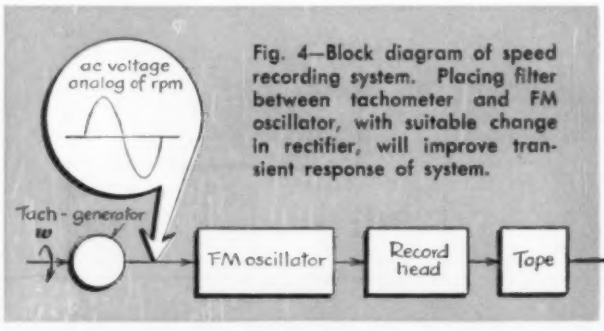


Fig. 4—Block diagram of speed recording system. Placing filter between tachometer and FM oscillator, with suitable change in rectifier, will improve transient response of system.

wire changes to a new value. The wire vibrates in a magnetic field provided by small permanent magnets, and the generated ac voltage is of wire frequency. The voltage is amplified and part of the amplified signal is returned as feedback to the wire to maintain continuous vibration. The output of the amplifier can then be recorded on tape without the use of an FM oscillator. The transducer in this case has the unique property of generating directly an FM analog of the stimulus.

Temperature Recording

Of first consideration in temperature recording is the familiar thermocouple. This is a satisfactory low-level device for measuring slowly varying temperatures. As such, the output can be applied directly to a high sensitivity galvanometer of a magnetic oscillograph and provide fair resolution of the data. Applied to an FM recording system, a high gain dc amplifier is a necessity. If a large number of slowly varying data channels are to be observed, then a commutator should be used. A commutator is sometimes used in the recording of temperature data on a magnetic oscillograph.

With careful design, the time lag of a thermocouple can be reduced slightly. However, simple compensating circuits can provide a thirty-fold reduction in effective time lag.[2] This improvement, however, is accomplished at the expense of a large reduction in the available electric power due to the increase in the output impedance of the network. Two simple compensating circuits with transfer functions are shown in *Fig.* 7. These particular circuits may be generally described as peaking circuits; i.e., the circuit presents a relatively low impedance to a rapidly changing input signal and in this way compensates for lag in the source signal. Compensating circuits must be properly designed for a given set of operating conditions of the thermocouple as well as for mechanical considerations. After initial circuit design, the values of R_1 and R_2 are changed for new conditions of operation.

The response of the system can be further extended through the use of an amplifier to overcome the insertion loss of the compensating network. The amount of improvement of response attainable by

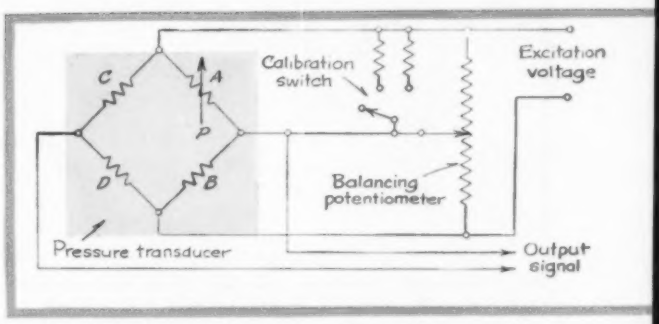
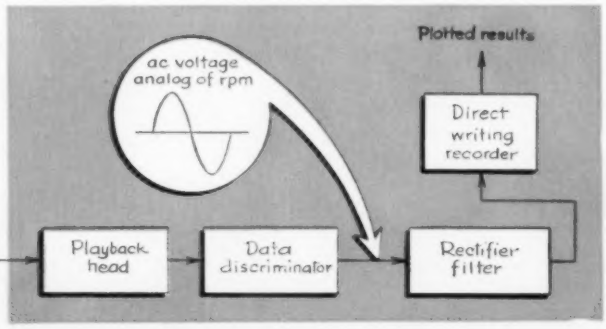


Fig. 5—Wheatstone bridge principle is widely used in instrumentation applications where stimulus is a motion that can be linked to means of varying resistance in one or more legs of the bridge circuit.

this method is limited generally by the signal to noise ratio that can be tolerated.

In recording temperature data on a magnetic oscillograph, the compensating circuit must be interposed between the thermocouple and the galvanometer. With a magnetic tape recorder as the data storage device, the compensating circuit can be inserted between the data discriminator and the direct writing recorder. If much transient temperature data require compensation of this nature, it then becomes practical to use an analog computer to accomplish the time lag compensation. This could conceivably be refined to the point where the time constants of the compensation circuit would be varied according to the changing test conditions also recorded on the tape.

A resistance thermometer may also be used to measure temperature. The thermometer element is an active leg of a bridge similar to the pressure transducer using a Wheatstone bridge with dc voltage excitation. The bridge output is a function of the magnitude of the excitation voltage and the variations in resistance of the thermometer element. However, the magnitude of the excitation voltage is limited due to heating effects in the legs of the bridge. It would be desirable for the sake of sensitivity to have large resistance values in the thermometer element, but this implies a coil construction of many windings with long thermal lag. Generally, the remarks which apply to compensation of the thermocouple system also apply to the resistance thermometer.



Hydraulic Flow Recording

For a specific example, the measurement of fuel flow will be considered using a volumetric type of sensor. The volumetric flow transducer is essentially a section of pipe with flow straightening vanes. Exit flow from the vanes drives a freely rotating impeller which has a magnet rigidly attached to the rotating shaft. In the plane of rotation of the magnet—on the casing—there are one or more coils in which the rotating magnet induces

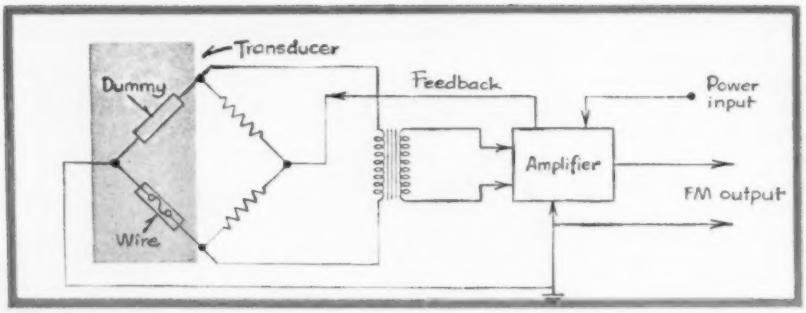


Fig. 6—New pressure transducer contains fine wire under tension vibrating at its natural frequency in a magnetic field. One end of the wire is attached to a diaphragm that expands or contracts, causing frequency of vibration to change. Voltage generated by the vibrating wire reflects pressure.

an emf. The frequency of this emf is proportional to the angular velocity of the impeller which is in turn proportional to the volumetric rate of flow.

The ac output of the volumetric flow transducer may be recorded on tape by modulating an FM oscillator with the output signal. On playback, the ac wave form from the data discriminator is then fed to a cycle counting integrator which furnishes a dc analog of the volumetric flow.

In terms of the relationship $Q = \rho AV$, where Q is mass flow in pounds per sec, ρ is fluid density in pounds per cubic feet, A is cross-sectional area in square feet, and V is velocity in feet per sec, the volumetric flow sensor provides only the AV portion on the right side of the equation. This requires that calculations be applied to the data to obtain Q. Since the density of the fuel is easily determined, the dc voltage analog of volumetric flow may be regarded as an analog of mass flow with the fuel at some standard temperature. The resultant data from the flow sensor must then be corrected for variations in temperature of the fuel. Again, applying analog computer techniques, the fuel flow signal can be corrected for temperature variations before final plotting.

Mass flow transducers are available that deliver a signal which is proportional to the mass of the liquid regardless of temperature variations and air bubble content of the fluid. The signals are sometimes difficult to obtain in a form which is easy to record. In any case, the complexity of the system is placed on the recording end rather than the playback end. This is not desirable in airborne installations and may not be desirable for many ground applications. The choice is controlled by cost, complexity, and the amount of error which can be tolerated due to gas bubbles in the liquid.

▶ Displacement and Vibration Recording

Angular or linear displacements are detected by several types of pickups such as potentiometers, resistance bridges, and variable reluctance devices. The physical construction of the transducer will depend upon the magnitude of displacement, the type of displacement, and the method of recording.

The amount of inertia or force loading that the transducer adds to the quantity to be measured may well determine the selection of the particular

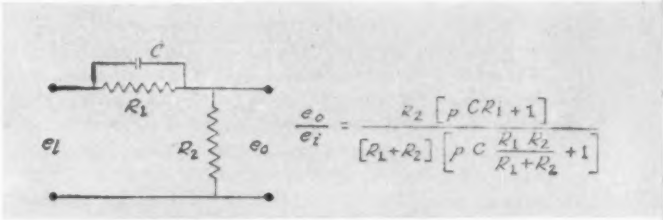


Fig. 7—Reduction of time lag in thermocouple circuits can be accomplished by use of indicated compensating circuits. Transfer functions show relationships between input and output voltages.

type. The method of getting the data on magnetic tape or oscillograph record does not differ from similar systems involving the type of transducer that is selected.

Vibration and acceleration transducers are both seismographic types of devices. The acceleration transducer, or accelerometer, is more obviously in this category than the vibration transducer since a weight is usually attached to a free end of the sensing element. Because of the relatively large mass associated with the sensing element, the accelerometer is insensitive to high frequency signals. On the other hand, high sensitivity to low-amplitude, low-frequency signals is provided. The vibration transducer is often a simplified accelerometer in which the weight has been removed. Three basic sensor devices used to detect vibrations and accelerations employ piezoelectric, variable reluctance, or strain gage sensing elements.

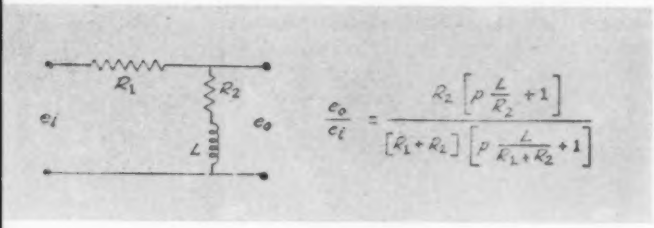
A piezoelectric sensor contains a crystal or ceramic element. As the element undergoes physical changes due to the forces of the vibration, a potential difference is created between two faces.

In the variable reluctance unit, a permeable metal plate is constrained to one axis of motion and is restrained from motion by springs. As a signal causes the plate to move relative to a coil, the reluctance of the magnetic circuit is varied causing a change in the inductance of the coil.

Sometimes, strain gages are used to measure vibration. These apply only when the member subjected to shake is slender, such as the compressor blade on an axial flow jet engine. Two strain elements are cemented on the blade, one directly opposite the other. These legs comprise active legs of a bridge and with proper excitation furnish an

output proportional to blade deflection amplitude.

If the spectrum of vibration frequencies to be explored does not exceed 5000 cps, then it is practical to record the data signal on magnetic tape using frequency modulation. A higher frequency range requires the use of direct recording methods. Vibration data can be recorded on a good magnetic oscillograph to about 5000 or 6000 cps with excellent fidelity. However, the composite waveform often defies analysis. On the other hand, data recorded on magnetic tape can be played back repeatedly for frequency spectrum studies or harmonic analyses.



Accuracy Considerations

The accuracy of any data system depends on many things. Fundamentally, errors of a system may be grouped under internal and external sources. Some internal sources of errors are hysteretic effects, nonlinearities, standing waves, attenuation of the signal due to line length to the transducer, and attenuation of the signal due to frequency response limits.

External errors, or errors due to environmental conditions include stray electrostatic and electromagnetic fields, vibration, gravitational loading effects, leakage currents, and temperature variations. One may well wonder at this point how any worthwhile data can ever be obtained. Fortunately, the art of instrumentation has achieved a state of development where practices have eliminated most of these sources and have greatly minimized others. The manufacturers of instrumentation, data recording, and data processing equipments have kept pace with the artistic end, and as a result it is possible to obtain overall system accuracies in the neighborhood of ± 1 per cent. This depends on the skill of the personnel who have contact with the instrumentation, recording, and processing of the data and the techniques and equipment used.

Nonlinearities contribute a large measure of error to a magnetic tape system. In the case of FM recorded data, the data signal from the discriminator contains the composite nonlinearities of the data transducer, the FM recording oscillator, and the discriminator itself. Consequently a calibration curve taken on a direct writing recorder will not be a straight line of data units versus deflection units but in a literal sense a curve. An exaggerated composite and hypothetical calibration curve of this type might appear as shown in *Fig.* 8(a). The best straight line drawn over the entire range may deviate from the curve by ± 3 per cent or more.

To improve the linearity of the plotted results, the zero setting of the scale and zero set amplifiers of the direct writing recorder may be adjusted so that the axes are translated to the coordinate points *r* and *p*. Thus, the data of interest ranges from *p* to *q*. To improve the resolution of the data, the gain or scale setting of the amplifier may then be adjusted so that *r* and *s* cover full scale deflection.

This manner of treating the analog form of the data applies only when the dynamic range does not cover the full range of the data originating transducer. If the full range is desired, then a more inclusive method of linearizing such as found in analog computer techniques may be used. The data are fed to a circuit with the output to input relationship of the linearizing function in *Fig.* 8(b). The calibration curve of *Fig.* 8(a) is also used here. The resultant is then a straight line relationship between the analog deflection units and the data.

The adjustments for linearizing are time consuming and any improvement in the final data would be at a sacrifice of time. It must be at the discretion of whoever must analyze the data to specify the degree of accuracy tempered by the time delay or added cost.

Aside from linearizing techniques, the accuracy of a system can range anywhere from ± 1 per cent to ± 10 per cent—exclusive of the transducers and converters on either end of the system.

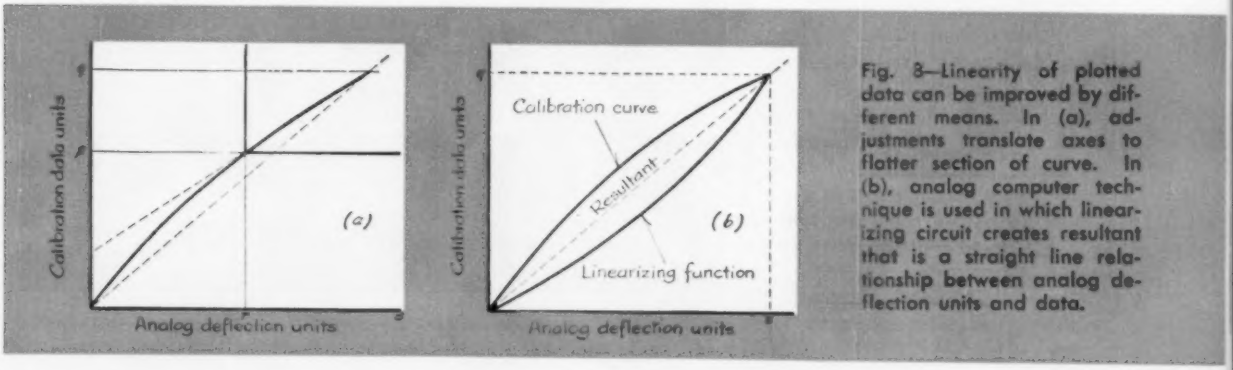


Fig. 8—Linearity of plotted data can be improved by different means. In (a), adjustments translate axes to flatter section of curve. In (b), analog computer technique is used in which linearizing circuit creates resultant that is a straight line relationship between analog deflection units and data.

▶ Playback

The playback system is the last stage in the train of processing the data by analog methods. As has been described, in the digital treatment of FM data, cards from the card punch machine receive further processing in a digital computer.

The various ways in which data from magnetic tape can be processed in analog form are manifold. A playback system is described in the block diagram of *Fig.* 9. The purpose of the patch panel is to maximize the flexibility of the playback system. It also allows a simple means of adding new equipment to the system. The digital readout apparatus may be in the form of an electric typewriter with an attached paper tape punching device. The data on the paper tape may then be introduced to a digital computer for further processing.

A light beam oscillograph is shown as an analog readout device and is listed as such simply to denote the application of a high frequency response device. It could in fact be any type of high frequency data-plotting device which yields a time history of the data and allows direct visual conversion of the analog plot to data units.

In concluding this article, it would be presumptuous to recommend blind entry into the field of magnetic tape data recording. Anyone giving serious consideration to magnetic tape for any kind of data application—including business as well as scientific application—would be wise to study carefully their needs with regard to magnetic tape. A close examination may reveal that no appreciable improvement can be gained. After all, the chart recorder, photopanel, and oscillograph have been around a long time, and within limits can provide adequate results. On the other hand, examination may show that the storage capabilities of magnetic tape may be sufficient to prompt entry into the field. In any event, the information contained in this article and its companion article will provide a general knowledge of magnetic tape systems.

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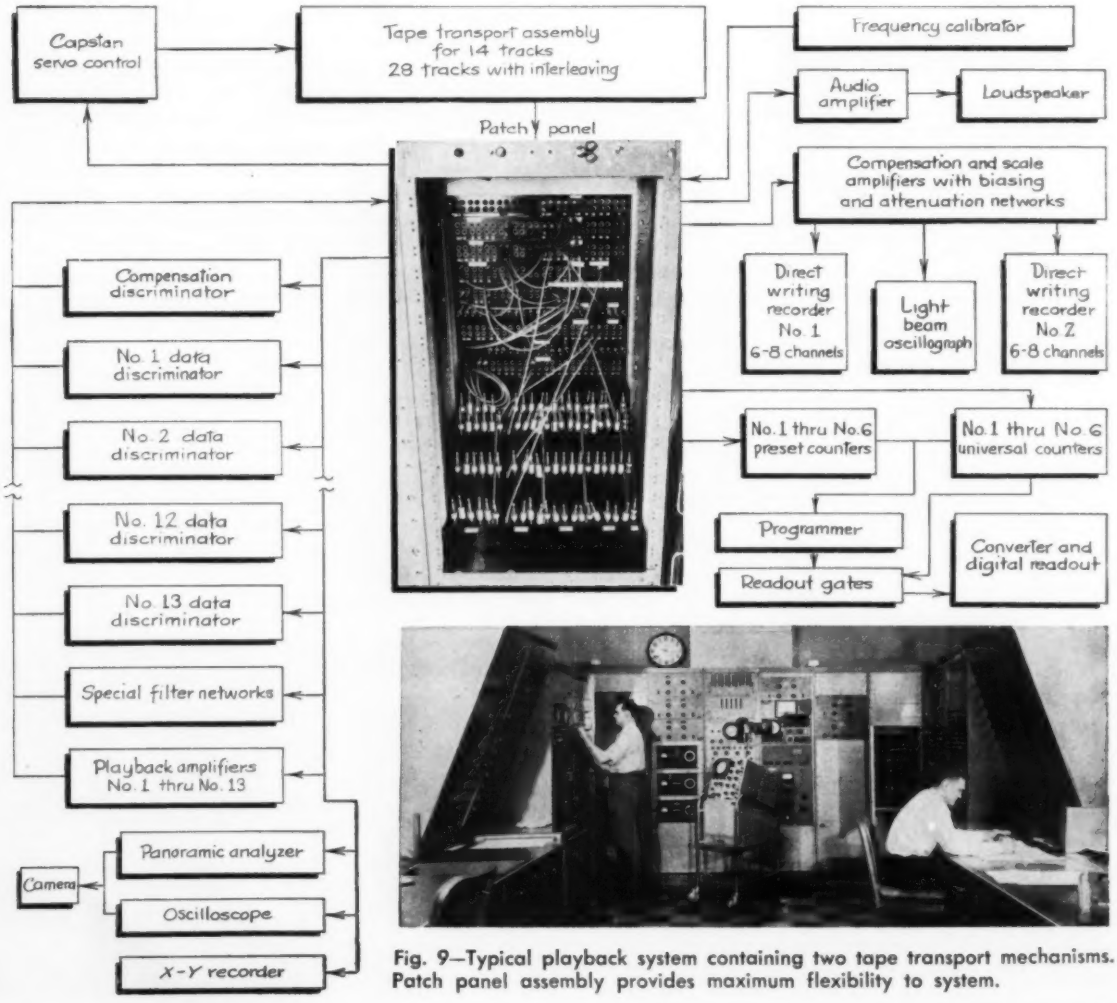


Fig. 9—Typical playback system containing two tape transport mechanisms. Patch panel assembly provides maximum flexibility to system.

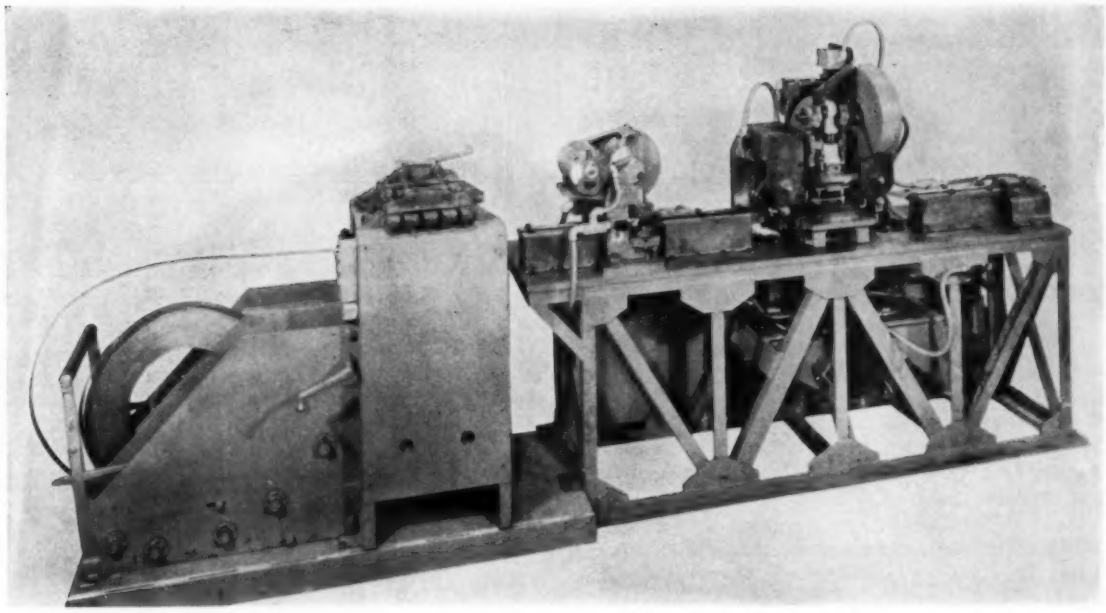


Fig. 1—Special purpose machine for automatically producing gasket retainers from steel strip employs four standard machines in its construction. Strip is fed by coil feeder at left, passes through leveler, is cut off in first press, and notched in press at right. Part is then formed into U-shape and ejected. A storage rack (not shown) may be positioned in front of the machine to receive finished parts.

INTEGRATING STANDARD MACHINES

TO PERFORM SPECIAL JOBS

By **JOHN A. STALEY,** John A. Staley Co., Milwaukee, Wis.

DEVELOPMENT of special purpose machines through integration and automatic control of standard equipment is often the quickest and least expensive way to automate a production process. In addition to favorable lead time and cost factors, there are the advantages inherent in use of fully developed standard units that are familiar to average operating and maintenance personnel.

An automatic machine for producing dishwasher door gasket retainers, *Fig.* 1, is a case in point. Designed by Percer Engineering Co. for the John A. Staley Co., the machine was fabricated by Felcon Tool & Die Div. of Spincraft Inc. for use at the Milwaukee plant of Hotpoint Co.

The machine handles steel strip 1⅛-inch wide by 0.041-inch thick. Operations include uncoiling, leveling, measuring, cutting to length, notching, bending into U-shape, and transferring finished parts to an unloading rack. Output is 600 parts per hour.

Four standard machines—a coil feeder, a sheet leveler, a cutoff press, and a notching press—are incorporated in the automatic unit. Standard catalog items such as cylinders, clamps, limit switches, pushbuttons, and control relays are also employed. Tooling for cutoff, notching, and bending is special, but is of simple design. A base, guide tracks, an ejecting mechanism, and an unloading rack complete the assembly.

In operation, steel strip is threaded through the leveler and advanced by means of a *Jog* button on this unit. Thereafter, cycling is automatic and is

initiated by pressing a *Cycle Start* button. Limit switches and an *Emergency Stop* button assure proper and safe operation of the machine.

As stock is fed by the leveler at a speed of 100 fpm, it is guided along horizontal tracks. When the leading edge of the strip contacts a limit switch, power to the leveler is shut off. However, due to overtravel of the leveler, the stock continues to advance until it actuates a second limit switch at the far end of the guide track system. This switch operates the solenoid of an air valve to effect clamping of the advanced portion of the strip by means of cylinders. At the same time, the cutoff and notching presses are caused to single-cycle. Thus the advanced strip is clamped, cut to a 60-inch length, and notched.

A limit switch contacted at the bottom of the cutoff press stroke operates the solenoid of an air valve controlling the motion of two bending cylinders. These cylinders are mounted in the machine base in a position below and on each side of the notching die. As they rise vertically together, rollers linked to the piston rods lift and wrap the ends of the part into a U-shape around bending dies placed at the sides of the notching press.

Each bending cylinder must contact an individual limit switch at the top of its upstroke before the next action can occur. When this condition is met, the piston rods of the bending cylinders retract.

Full retraction of one of the bending cylinders operates another limit switch, initiating two further actions: 1. Release of the clamping cylinders. 2. Operation of two ejecting cylinders. The latter cylinders push the finished part forward into a storage rack which is positioned in front of the notching press.

Retraction of the ejecting cylinders is automatically effected through operation of a limit switch upon completion of the ejection stroke. On its return, the piston rod of one of the ejecting cylinders operates a limit switch that signals the leveler to start, and the cycle repeats automatically. A control on the storage rack will stop the machine in the event of overproduction or failure of the operator to unload the rack. Because of its automatic operation, the machine requires only a part time operator.

According to Mr. Ray Hermann, manager of manufacturing engineering at Milwaukee, the primary consideration which led the Hotpoint Co. to avail themselves of the services of an outside supplier to furnish this equipment was that company personnel qualified for such work could not be diverted from regular duties. In this and in similar cases, a reputable outside supplier is often in a position to render valuable service in implementing a company's automation program by virtue of the special talent he has available, often with a background of experience on similar jobs.

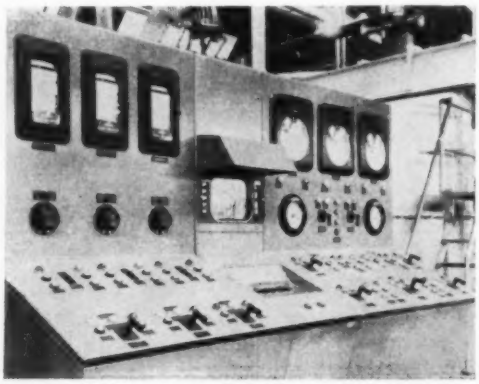
TELEVISION CAMERAS MONITOR PULPING PROCESS

CLOSED-CIRCUIT television has been installed at the Kearny plant of Western Electric Co. Inc. to obtain maximum production efficiency from two 3000 gallon hydrapulper tanks feeding pulp insulating machines. Two General Precision Laboratory Inc. television cameras—one focused on each of the two tanks—transmit a continuous picture of the hydrapulping process via coaxial cable to a 14-inch monitor located at a central control panel in an adjacent building.

The television screen provides a full view of pulp loading conveyors and processing equipment so that the operation of automatic controls can be verified. While watching the televised pictures, the operator starts the hydrapulper's 45-inch diameter rotor blades revolving, turns on water which flows from pipes circling the interior of the tank top, and dumps 1100 pounds of sheet pulp into the tank. Since the size of the tanks made it necessary to locate them remote from the control point, the operator could not see to activate the automatic pulp conveyor for loading the tanks. In addition to saving time and manpower, the view on the television screen makes it possible to verify the location of any personnel when the automatic process is started and eliminates a possible safety hazard.

Used in conjunction with automatic controls, the television system speeded production and permitted greater flexibility in locating the pulp insulating equipment.

The 15-minute automated pulping process is the first step in the production of paper insulated exchange area telephone cable.



DEVICE FEEDS COMPRESSION MOLDER

PRODUCTION SETUPS that employ automatically cycling machines can be more highly automated by the addition of devices to feed parts or material automatically. Realizing this, F. J. Stokes Corp. has developed an automatic plastic rope feeding attachment, *Fig.* 1, for use with two models of their automatic compression molding machines. The feeder can be attached to new presses and presses that are in service.

Operation

As illustrated in *Fig.* 2, glass-fiber reinforced polyester resin in extruded rope form is cut into pieces of uniform length by a knife blade that operates on the outstroke of an air cylinder. Also during this motion, two feed jaws are slid back along the rope without gripping. The knife blade is then retracted on the instroke of the air cylinder and the feed jaws grip the rope and feed the next section forward into the cutting position.

Severed sections of rope fall into a guide chute that directs them to feed tubes in an upper feed plate. The upper feed plate, which contains up to 24 feed tubes equally spaced around its periphery, is synchronized to index and receive each severed piece in an individual feed tube.

The feed tubes are connected at their lower ends to a lower feed plate that indexes along with the upper feed plate. The pattern of tube openings in the lower feed plate corresponds to the pattern of receptacles in a loading board mounted beneath. Thus, the loading board collects the rope sections as they fall through the feed tubes and holds them in the proper arrangement to drop into the cavities in the mold when they are released.

Automatic transfer of pieces from the loading board into the cavities of the lower mold half completes the automatic rope feeding cycle. Further operation of the feeding attachment refills the receptacles in the loading board in preparation for the next compression molding operation.

Mold Changeover

The rope feeding attachment can be used to automatically fill mold cavities located anywhere in the platen area and in virtually any pattern. Changeover for different molds is readily accomplished by substituting a lower feed plate and loading board to suit the new cavity pattern, and by reconnecting the feed tubes from the upper feed plate. The fixture can accept a wide range of rope diameters, and the cutting length setting is adjustable.

The advent of this automatic feeder makes possible lower operating costs that are expected to promote fuller exploitation of the mechanical and electrical properties of plastics such as glass-fiber reinforced polyester resins for a greater variety of products. Of more general interest are the broad possibilities of adapting some of the design principles of this mechanism to automatic devices in other industries and for other materials.

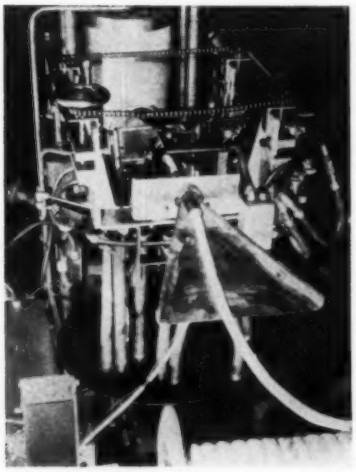


Fig. 1 — Glass-fiber reinforced polyester resin rope is automatically cut to length and fed to the cavities of a mold by this feeding attachment for compression molding machines.

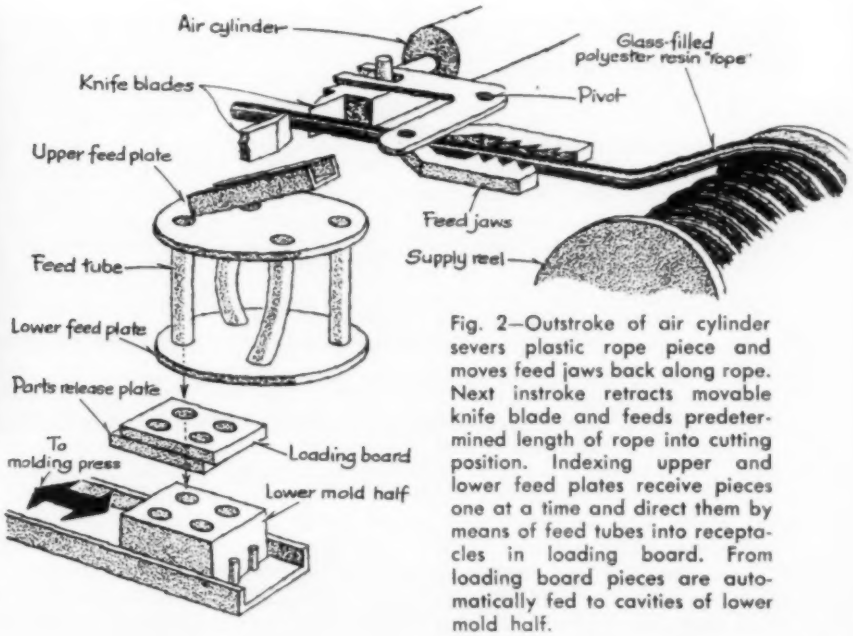
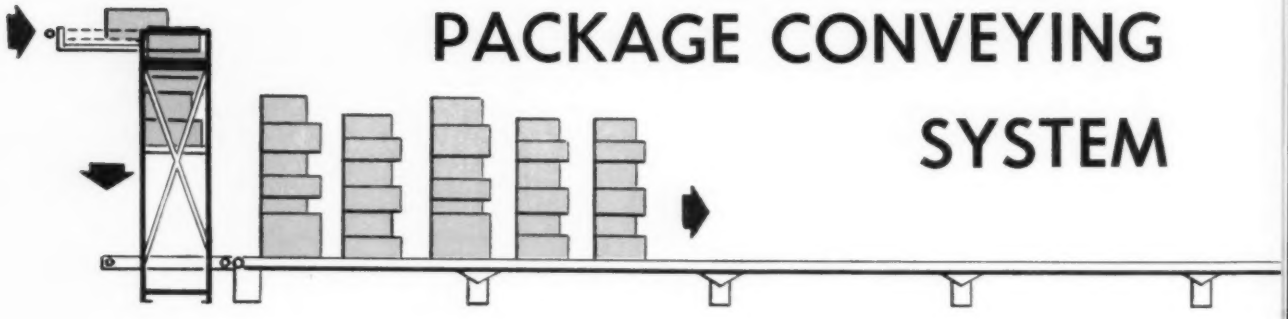


Fig. 2—Outstroke of air cylinder severs plastic rope piece and moves feed jaws back along rope. Next instroke retracts movable knife blade and feeds predetermined length of rope into cutting position. Indexing upper and lower feed plates receive pieces one at a time and direct them by means of feed tubes into receptacles in loading board. From loading board pieces are automatically fed to cavities of lower mold half.

AUTOMATIC STACKING ADDS THIRD DIMENSION TO PACKAGE CONVEYING SYSTEM



By **JOHN W. STILES**, President, Island Equipment Corp., Long Island City, N. Y.

AUTOMATION has made noteworthy advances in manufacturing areas of progressive plants, but, too often, accumulation and shipping areas have been overlooked in management planning. Examination of existing shipping operations will usually reveal fertile fields for major economies if proper materials handling techniques are adopted. Sometimes off-the-shelf handling equipment will suffice to accomplish this objective, but often new techniques and new machines are required to thoroughly overhaul out-of-date shipping procedures. A case in point is an automated handling system engineered and installed by Island Equipment Corp. for use in a distribution warehouse of Mangel Stores Corp., a large retail chain store organization.

Problem Analysis

The materials handled in the distribution warehouse are garments and small wears. Each day retail stores send in orders for various quantities of both items. Hanging garments are selected and moved on racks over an efficient monorail system. This system operates independently of the small wears activities and was considered satisfactory for future operations.

Orders for small wears are accumulated in pick-order containers by store locations and then several pick orders are packed into shipping cartons for delivery to the stores. Since small wears cover a large variety of items and each retail store order is for different quantities, shipping carton sizes must vary and a large inventory is carried to supply the demand. A large volume of small wear shipments are made each day and the existing system capacity was considered inadequate.

The problem was further complicated by the fact that only two shipping docks were available and only two delivery trucks could be accommodated at one time. Therefore, it was imperative that shipments be ready and waiting when the trucks backed into the loading docks.

When it became evident that the existing small wears shipping procedures were antiquated and that economies could be gained by modernization of the handling system, various conventional methods were examined to determine their feasibility for use in the small wears shipping department. For example, the use of high-lift fork trucks and automatic pallet loaders was investigated and discarded since palletization is most applicable and efficient in handling uniform-sized packages in unit loads. Since small wear cartons were filled with varying quantities of goods, a single uniform-sized carton was not practical or economical.

The use of gravity storage conveyors was also studied. In other applications these units have been utilized in shipping areas by laying out single lines or stacking conveyors one above the other in racks. Both arrangements were deemed impractical in this case since they would involve costly manual operations in order to make full use of the available cubic storage space. Many other materials handling systems were examined and discarded before it was decided to start from "scratch" and custom design a new type of system.

Primary Considerations

The two primary considerations that required resolving before the custom design could be made were the package size and limitations imposed by having only two shipping docks for delivery trucks. A study of carton sizes disclosed the feasibility of standardizing the length and width of these containers within narrow limits and providing different cubic capacities by varying the height of the units. Therefore, five standard cartons were adopted with the same dimensions except the height.

Planning for modernization of existing facilities frequently provides the seeds of inspiration which often develop into innovations for accomplishing routine tasks. Such an environment furnished the stimulus for the development of a unique descending stacker carton handling machine. It is possible that this equipment will do for conveying operations what the automatic pallet stacker has done for unit-load handling.

Certain by-product economies resulted from this change—both in purchasing of the units and in inventory requirements.

The next phase of the preliminary study concerned handling the standard package units as advantageously as possible through the limited storage space immediately in front of the two delivery docks. Analysis of the requirements highlighted the need for making the fullest possible use of "air rights" in this area. This led to the conclusion that a machine was needed to stack the cartons automatically so that they could be moved to the delivery docks by powered conveyors. Since there was no such machine commercially available, a new machine was devised for this purpose.

The automated descending stacker, which evolved as a result of this installation, is an innovation in package-handling equipment. It is essentially a vertical rigid-arm conveyor or elevator which, during the down portion of its operating cycle, receives packages successively and stacks them one on top of the other. When the unit completes its downstroke, a stack of tiered cartons has been developed which the machine discharges onto an accumulating belt conveyor for transport to the delivery docks. The bed of the stacking unit then ascends to its upper position and is ready to start another cycle. The entire operation is automatic, requires no oper-

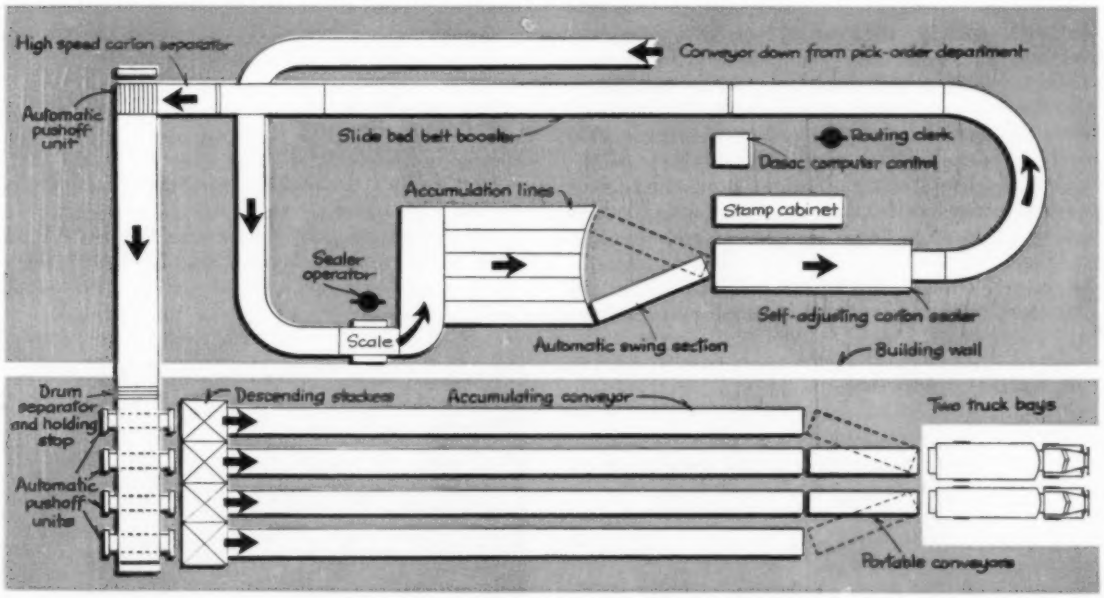


Fig. 1—Flow diagram of the small wears carton handling system in a distribution warehouse of Mangel Stores Corp. Standard design conveyors were used throughout the system. The descending stackers and the automatic swing section feed for the carton sealer were conceived and developed to solve the special problems presented by this installation.

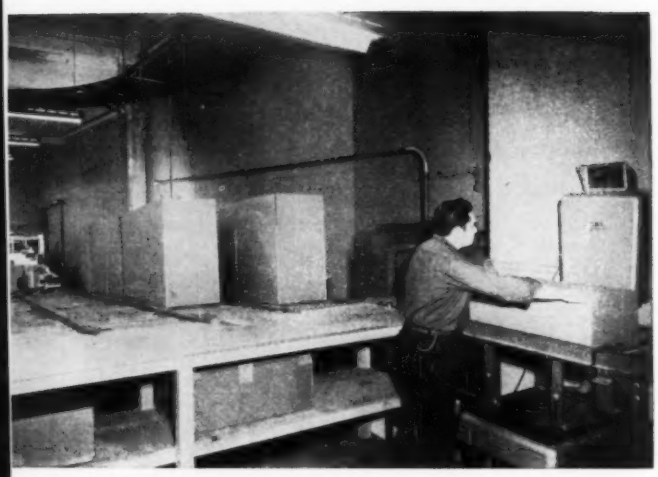


Fig. 2—Sealer operator weighs each carton coming from the pick-order department on another floor. He records the weight and store number on a punch card which is used for preparation of the bill of lading. Cartons are then fed into one of the five accumulation lines leading to the automatic carton sealer. Automatic swing section then connects the line holding the most cartons with the sealer unit.

ator in attendance, and will handle cartons in mixed assortments of various heights.

▸ Planned Automation

With the adoption of standardized cartons and the successful development of the automated descending stacker, plans went forward to provide completely automated receiving, storing, and shipping facilities for the small wears distribution warehouse. Engineered into the system were over 1000 limit switches, a Dasac computer supplied and installed by Dasol Corp., various combinations of powered conveyors leading to self-adjusting carton sealing equipment, and the automated descending stackers. The schematic drawing, *Fig.* 1, illustrates the layout of the equipment associated with the upgraded shipping procedures for small wear cartons.

▸ System Operation

In order to illustrate the various features of the small wears handling system, it will be apropos to follow the path of a typical carton through the various stages of the setup. As previously mentioned, merchandise is packed into one of five standardized containers with the significant variation in carton size being the height. Experience has shown that, on the average, the contents of seven pick-order boxes are required to fill one shipping container. This is done on an upper floor of the warehouse. The unsealed carton is then conveyed to the first floor where it is weighed by a sealer operator, *Fig.* 2. He marks the weight and store number on the package and records the same information in an IBM key punch adjacent to the scale. This data is later used in making up a bill of lading covering each store's daily shipment. At the same time, the store number of the package is automatically fed into a special tally unit which turns on a light corresponding to the store. The tally unit allows a double-check of package counts going to each store, and a later operation automatically cuts off the light when the carton is routed to a descending stacker.

The sealer operator then pushes carton onto one of five accumulation lines ahead of the self-adjusting carton sealer. Each line accommodates one of the five different sizes of cartons being used. Connecting the accumulation lines to the sealer unit is a swing section which automatically moves into position in front of the line holding the largest number of cartons. The sealer unit is unique for this type of soft goods operation. Since the containers tend to bulge, the unit squares the package prior to sealing. It also adjusts automatically to suit the package being sealed. However, since this automatic adjustment requires approximately 30 seconds, each accumulation line holds the same size cartons and thus reduces the number of changes required. The automatic sealer unit will handle packages varying from 6 to 24 inches in height and from 16 to 19 inches in width.

▸ Carton Routing

After sealing, the package is conveyed to a routing station, *Fig.* 3. An operator notes the store number of the carton and punches the number into a Dasac computer control panel at his side. This action pro-

Fig. 3—Routing clerk enters store number into the Dasac computer panel at his left. This action programs the carton to one of four descending stackers and indicates by means of a light location of the proper address stamp in the rack to his rear. In the left background can be seen the accumulation lines leading to the carton sealer.

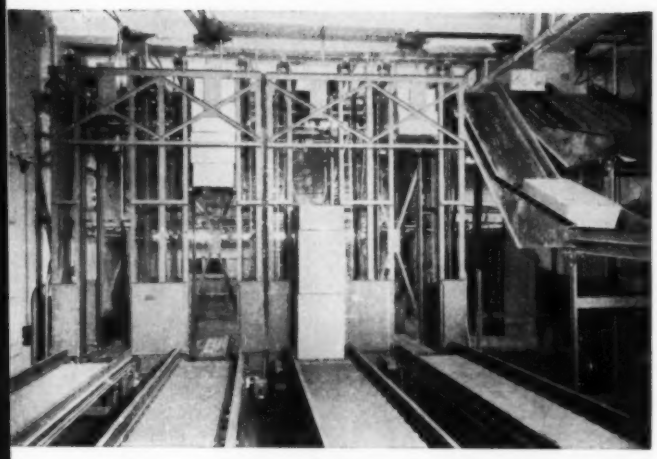


Fig. 4—Cartons are routed by the computer to one of these four descending stackers. Pushoff units load a carton on the stacker which automatically descends until the top of this carton is flush with the pushoff unit. The stacker is then ready to accept another carton. The overall height of any stack is limited to six feet. However, the stacker will accept successive cartons of different heights. When a stack has been completed and reaches the bottom of the unit, flat-top chain conveyors move the stack out of the unit and deposit it on the accumulation lines leading to the shipping dock.

grams the carton to one of the four descending stackers, subtracts the store number of the package from the special tally unit in the sealer area, and locates the proper address stamp in a rack behind the operator. The operator turns to the stamp rack, removes the address stamp from the compartment indicated by an illuminated lamp, and stamps the address on the carton.

When all cartons consigned to one store have passed the routing clerk, all lights for that particular store should be out on the special tally board in the sealer area. If any lights remain on, it indicates that an error has been made in routing and all packages are checked until the misaddressed carton has been located. No shipments are made without first verifying that all lights are out on the tally board.

In addition to actuating the tally unit and indicating the proper address stamp, the routing clerk's control panel also assigned the carton to one of the four descending stackers. Correct routing for each store is programmed into the computer unit so that the operator has only to punch a button on the panel. Additional flexibility is provided by the inclusion of a switching dial on the control panel. This allows the operator to change the programming of cartons consigned to accumulating lines on the shipping dock in order to obtain peak dock efficiency. Bypassing the standard computer program, the operator can route packages to shipping so that each line on the dock is filled completely in sequence.

▸ Conveying and Stacking

After a carton has been stamped by the routing clerk, it is conveyed to a higher level leading to the top of the stacking units. In order to change the position of the carton from lengthwise along the conveyor to crosswise, the package is fed onto a high speed separating belt conveyor which spaces the cartons before they reach an automatic pushoff unit. This unit receives the carton lengthwise and pushes it onto another conveyor at right angles with the first so that the carton is lying crosswise to the conveyor travel. The package is then conveyed to a drum separator and holding stop which holds back several cartons and releases them at a rate of 8 per minute to a section of live roller conveyor extending across the entrances to the four descending stackers. As the carton moves across the roller conveyors, it automatically is stopped in front of one of the stackers and is pushed into the unit. This action was predetermined by the routing clerk when he entered the store number into the computer.

As each carton is pushed onto the descending stacker, the unit automatically descends until the top of the carton is flush with the pushoff unit and ready to receive the next carton. Successive cartons are added to the stack until the stacker elevator reaches the bottom of its stroke and trips a limit switch. This actuates two chain conveyors which move the stack onto an accumulating conveyor leading to the shipping dock. The conveyor stops as soon as the stack has cleared the stacking unit. Successive stacks of cartons are discharged onto the accumulating conveyor and each load causes the conveyor to advance a short distance toward the delivery trucks. When the accumulating conveyor has been completely filled with stacks, it trips a limit switch which causes the computer to program successive cartons to another stacker.

Short sections of portable conveyor are used to move stacks from the accumulation lines to the proper delivery trucks. In addition to the four automatic descending stacker handling lines, the Mangel Stores installation has eight other conveyor lines which are served by slide chutes and gravity roller conveyors. However, the cartons feeding down these lines are not stacked but are lined up in a single row, one behind the other.

When a shipment is ready to be loaded on the trucks, the IBM punch cards prepared by the sealer operator are sent to a tabulating room. In a matter of minutes, data processing equipment prepares bills of lading for each shipment. By the time the truck is loaded, the accompanying paperwork is delivered to the shipping dock.

The Mangel Stores installation is an example of how careful engineering coupled with ingenuity can produce an automated system for selective accumulation and distribution of packaged merchandise. Through this installation, a new method of package handling has been added to the repertoire of the materials handling engineer.

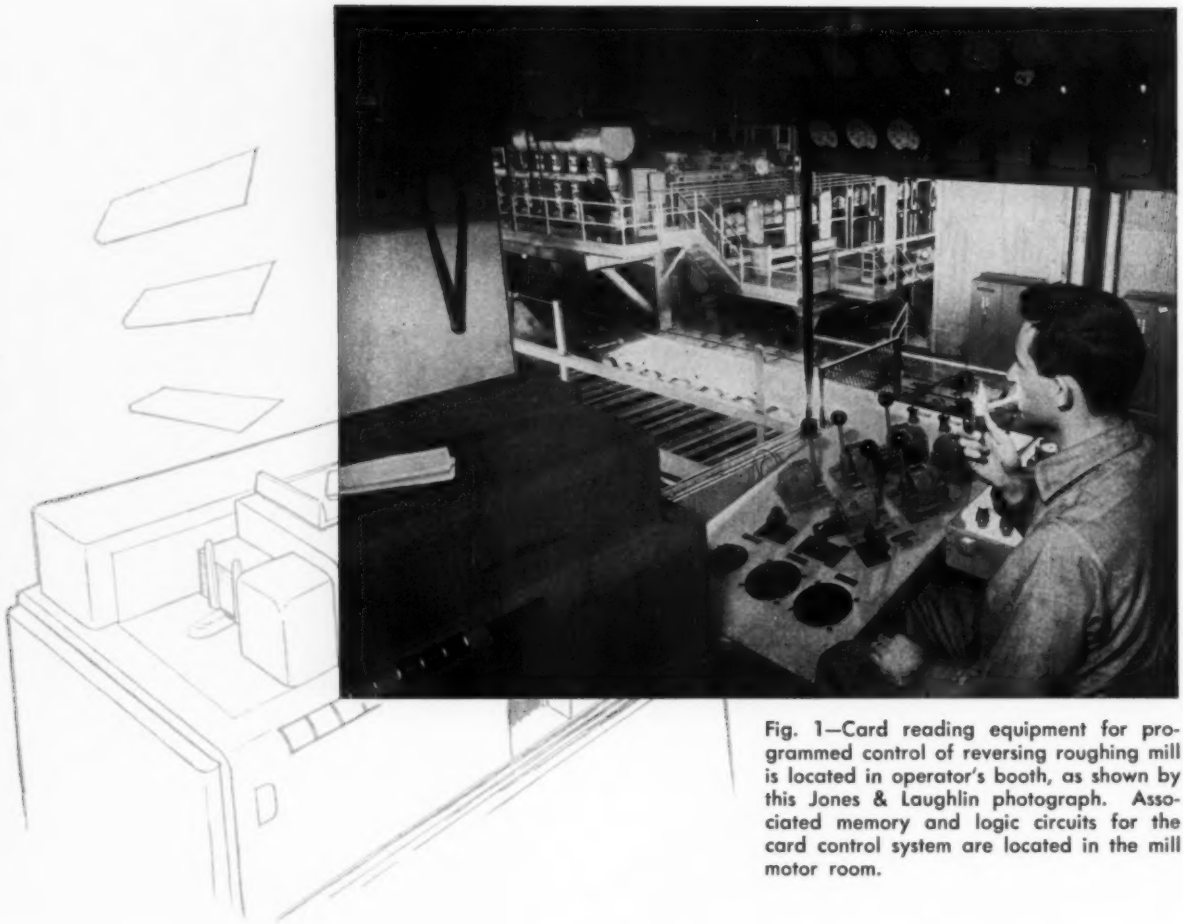


Fig. 1—Card reading equipment for programmed control of reversing roughing mill is located in operator's booth, as shown by this Jones & Laughlin photograph. Associated memory and logic circuits for the card control system are located in the mill motor room.

STRIP MILL USES AUTOMATIC

PROGRAMMED CONTROL

By E. H. BROWNING
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Where desired operations can be translated into numerical values, and where equipment response can be controlled and monitored by electrical means—a potential application for numerical control exists. As control complexity increases, benefits can be obtained by programming.

IN OPERATING a conventional manually controlled reversing mill, an operator must exercise superior judgment and alertness—that can be developed only by experience. In a single day, he may be responsible for rolling a number of schedules, each consisting of five or more passes through the mill, according to the product to be produced. For each of these passes, the operator must control mill speed, mill direction, and roll positioning. Further, for each schedule, he must control the various work handling tables associated with the mill, guides for aligning the material, and water sprays. If there is an edger, he must also control the setting of the edger rolls.

With many decisions to be made very rapidly, it is apparent that human error is possible, with consequent losses in production or product quality. A system which permits precise scheduled mill operation would obviously benefit both product quality and mill output.

Completely automatic operation is possible for a reversing roughing mill, part of a semicontinuous hot strip rolling mill, recently placed in production at the Aliquippa Works of the Jones and Laughlin Steel Corp. Under a new card-programmed system designed and built by Westinghouse Electric Corp. the roughing mill operator can press a single button to initiate the complete rolling sequence for a given slab, *Fig.* 1. Speed and roll openings of the edger and main rolls are predetermined for a complete schedule of up to nine passes by holes punched in a single punched card.

Fig. 2—Summary card punch manufactured by IBM has been adapted for use in the control system. One card contains information for a complete rolling schedule of up to nine passes through the reversing roughing mill.

Prepared beforehand, IBM cards are available for nearly every slab and strip size and for each grade of steel. These cards are prepunched to call for the optimum drafts and speeds that give uniform production at as high a production rate as possible.

A single IBM card includes all information required for a given schedule and controls: 1. Mill screw-down opening, from 0 to 14 inches in 1/32-inch increments. 2. Edger adjustment opening, from 6 to 44 inches in 1/16-inch increments. 3. Mill speed, at 115, 300, 440, 715, 880, or 1100 fpm. 4. Edger speed, which is matched to mill speed, but from 0 to 60 per cent slower to take care of draft in the horizontal mill; eight 7.5 per cent steps are available. 5. Direction of the mill. 6. Scale breaking edger adjustment. 7. Scale breaking edger side guards. 8. Scale breaking edger descaling sprays. 9. Descaling sprays on the delivery side of the mill. Also included on each card is a notation to indicate the last pass.

Mill Operation

When a stack of cards is inserted in an IBM card reader, *Fig.* 2, the mill operator can begin to roll a sequence of schedules. To roll the first schedule, the operator presses a *Schedule Advance* button, which causes the first punched card to be read by the card reader and its information stored. When the operator pushes a *Pass Advance* button, information applying to the first pass is utilized to set the separation and speeds of horizontal and vertical rolls. The slab then enters the edger and the mill.

To make mill operation automatic, a detector that responds to strip radiation is located on each side of

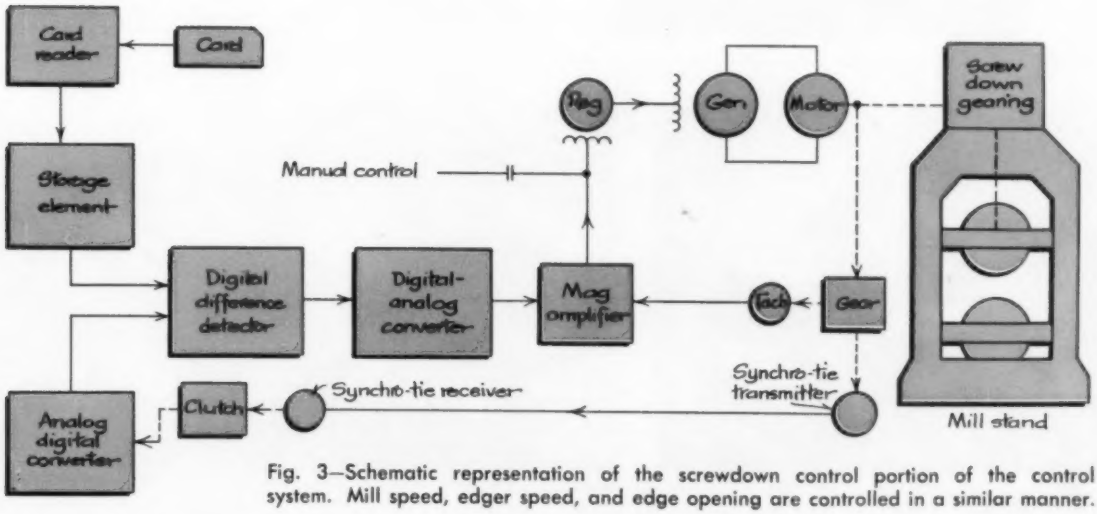


Fig. 3—Schematic representation of the screwdown control portion of the control system. Mill speed, edger speed, and edge opening are controlled in a similar manner.

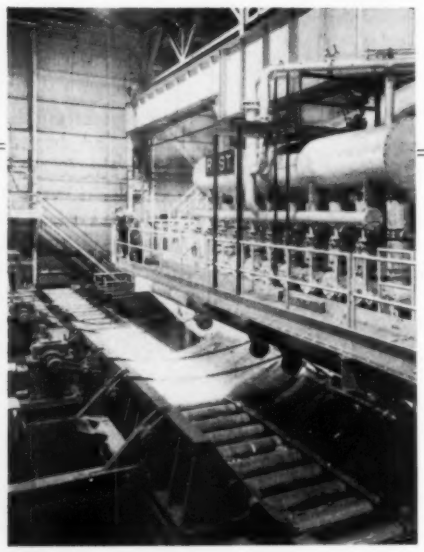
STRIP MILL USES AUTOMATIC PROGRAMMED CONTROL

the mill approximately 15 feet from the center line of the rolls. There is also a load detector on the mill to detect the instant the strip leaves the mill. When the slab has passed beyond the hot metal detector at the left of the mill, the mill decelerates to limit the travel of the slab after it clears the rolls. Immediately after the slab has passed beyond the rolls, the load detector initiates a signal which stops the mill automatically. Simultaneously, information for the next pass in the memory system of the control is used to reset the edger and main roll separations and to establish speeds and direction of rotation for the rolls. The mill is than automatically accelerated, and the slab enters the mill for the second pass and upon completing this pass, further adjustments take place according to new desired settings. Thus, mill operation proceeds entirely automatically once the operator has initiated the operation by pressing the *Pass Advance* button. However, if unsual conditions require, the operator can operate the mill manually.

If a sequence of slabs is to be processed identically, the operator needs only to press the *Pass Advance* button for each slab and full automatic operation for the rolling schedule will occur from the same card. If the next schedule is to be different, then pressing the *Schedule Advance* button will cause information from the next card in the reader to be extracted and the new schedule will be executed automatically when the *Pass Advance* button is pressed.

The system also provides for automatic control of scale breaking edger and descaling sprays. Scale breaking edger adjustment and scale breaking edger side guards, which automatically open after the first pass, automatically close after the last pass of the schedule so that they will be in a proper position to make the scale breaking pass on the next slab received from an oven or the blooming mill. Manual switches are operative on these drives at any time required.

Scale breaker edger descaling sprays are turned on automatically whenever steel is in the scale



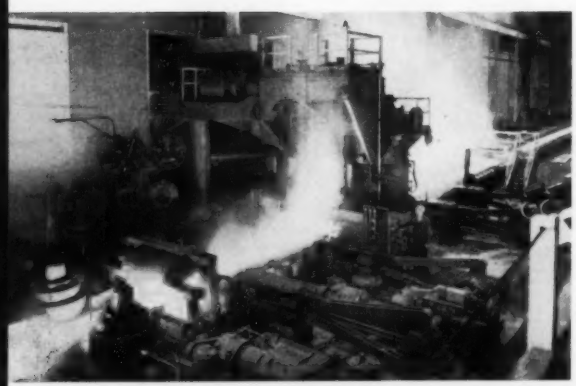
Reheating Furnace

OPERATION OF SEMICONTINUOUS HOT STRIP

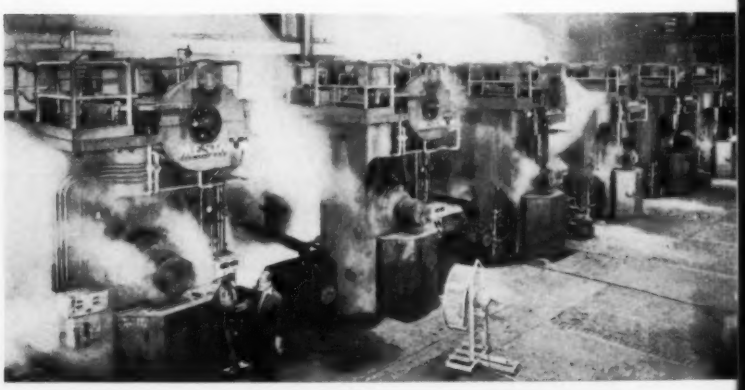
Mill, furnished and installed by the Mesta Machine Co., consists of a vertical scale breaker, a two-high reversing roughing mill with attached edgers, six 4-high finishing stands with three individually-driven edgers, and two revolving-mandrel down-coilers.

The new Jones & Laughlin mill is located near an existing blooming mill and is provided with transfer facilities between the mills to permit direct rolling of hot slabs without reheating. In addition, the new rolling mill contains two heating furnaces to permit the mill to operate independently of the blooming mill.

The sequence of operation for the rolling of a slab (from a heating furnace) to a coil follows this pattern: A lift of slabs is deposited on a depiler at the entry end of the furnace



Reversing Roughing Mill



Finishing Stands

breaker. Time delay relays adjustable between 0 and 3 seconds are incorporated to delay the turning on and off of the sprays to compensate for the distance between the scale breaking edger and the sprays. A switch is available on the operator's desk to select either manual or automatic operation of this set of sprays.

Descaling sprays on the delivery side of the mill are turned on automatically on all even passes and stay on as long as steel is in the mill. A switch is available on the operator's desk to select either manual or automatic operation of this set of sprays.

It can be seen that this system uses prescheduling to relieve the operator from the heavy responsibilities of manual control, thus permitting him to monitor the operation and to operate associated auxiliaries. Possibility of errors is further reduced since each card contains its own digital checking information.

▶ Control Operation

The schematic diagram, *Fig.* 3, illustrates signal process operations incorporated in Westinghouse's Prodac controls for automatically controlling screwdown, the separation between upper and lower rolls. In this system, information applying to screwdown is transferred from punched card into storage by the IBM card reader. An analog signal representing actual roll separation is transmitted from the mill to an analog-to-digital converter for conversion into digital form. When the operator presses the *Pass Advance* button to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to the digital difference detector. At the same time, the signal corresponding to actual roll separation is passed to the digital difference detector. Here a subtraction operation yields a resultant signal representing the difference between the actual and desired roll separation. This signal is then processed by the digital-to-analog converter to yield an analog signal for input to a magnetic amplifier. When output of this magnetic amplifier is supplied to a rotating regulator, an adjustable voltage drive adjusts the screws until roll separation is equal to that originally specified by the punched card.

Similar processes for information storage and signal conversion, matching, and amplification are used to control mill speed, edger speed, and edger opening.

ROLLING MILL

in the proper rolling sequence. The depiler elevator is lowered and the top slab stripped onto the furnace charging table where it is positioned by the furnace charging operator with respect to the furnace skids and side walls. The slab is pushed onto the furnace entry skids by means of the furnace pusher and stopped when load contact is made with the preceding slab.

When a slab call-light is turned on by the reversing mill operator, the furnace charge is advanced to discharge a slab. The pusher is then returned to the back position to repeat the cycle. The actual slab dropout is observed by the furnace charging operator on a closed circuit TV system.

The discharged slab is advanced on the furnace delivery tables to the vertical edger approach tables by the reversing mill operator. From this point, the roughing operation is automatically controlled by the automatic programmed control system. The complete rougher rolling sequence for each slab is initiated by a pushbutton.

Down-Coilers

As the slab passes through the vertical scale breaking edger, a width reduction is made to break furnace scale and furnish the desired slab width. After the head end is delivered from this unit, the vertical edger descaling header removes this scale. Further scale removal is controlled by a header located on the delivery side of the reversing mill.

After the slab leaves the vertical scale breaking edger, the edger and its approach table side guards remain open during subsequent passes in the rolling cycle. During the rolling of the slab, the attached edgers maintain the width.

The slab, or "breakdown," is delivered to the finishing stands where the head end is cropped, and its width and gage checked. The breakdown then enters the finishing scale breaker, and then passes through two finishing scale breaking descaling headers, one of which has taper spray control. It then enters six 4-high finishing stands. A continuous record of the thickness and width of the strip is obtained immediately after passing the No. 6 finishing stand, by means of x-ray and width gages. The strip then enters one of two mandrel-driven down-coilers. Three edgers have been installed on the finishing stands for width and edge control when rolling certain sections. These edgers are located before No. 1 stand, after No. 3 stand, and after No. 5 stand.

Maximum versatility for the new mill has been provided in the electrical installations. Every motor—from the entry table of the reversing rougher through the finishing stands, the runout tables, and through the down-coilers—is an individual drive.

Controls for the mill are located in three pulpit positions. The card reader for the programmed roughing mill is located in a raised pulpit in the immediate vicinity of the reversing rougher. The information handling equipment for this control is located in the mill's motor room. The finishing stands are controlled from the speed-operator's pulpit which is directly across from the six stands. The down-coilers are operated from a separate pulpit.

PRODUCTION LINE WELDING

By **JOHN H. BAUER,** Chief Manufacturing Engineer, Clyde Div., Whirlpool Corp., Clyde, Ohio

INFLUENCE of part design on production is effectively illustrated where major economies have followed minor design changes. As an example, baskets for home laundry automatic washers built by Whirlpool Corporation's Clyde Div. are presently produced with improved quality and lower cost thanks to minor design changes and to an altered production setup that now includes automatic facilities. Formerly the basket had a flat bottom except for an upturned conical portion at the center where a flanged tube and a ring of metal were inserted. The assembly of the tube, metal ring, and basket involved three angular welding operations performed on separate machines, each with its own operator.

In the redesigned basket most of the bottom is formed upward into a cone which at the top has a drawn return flange or cylindrical collar. In production operations this basket is joined to a flanged tube, *Fig.* 1. The shape of the flange on the tube is designed to fit the form of the drawn cone in the basket.

As an initial operation the tube is pressed into place, passing through the collar such that the tube flange rests inside the basket cone. Subsequently the assembly is manually placed bottom up on a Progressive welder; there it rests on a cross track until pushed into welding position, *Fig.* 2. Once loaded and started the welder operates automatically: An upper electrode pilot is lowered into the tube until a beveled step of the electrode presses against the conical surface to be welded; the lower platen of the press is elevated, raising a mash welding wheel that is tilted to conform to the inside of the basket cone along the line to be welded. The basket and upper electrode are rotated, pressing heavily against the mash welding wheel for the necessary welding force. After the welding cycle is completed, the electrodes retract and the basket is pushed along the track by the next basket entering the welder. Subsequently the basket is tilted and dropped onto another track leading to an automated Resistance welding machine.

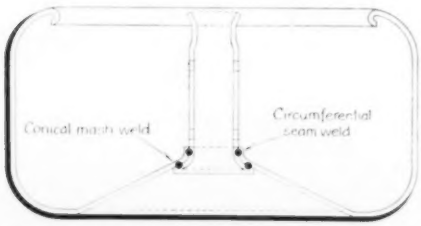


Fig. 1—Vertical section through axis of metal basket assembly for automatic washer shows location of welds which join basket to hollow center tube

At this second welding station the basket rolls into a cradle and is automatically loaded into the welder where the basket collar surrounding the hollow tube is automatically seam welded to the tube, *Fig.* 2. After this circular seam weld is completed, the assembly is loaded automatically onto a track and directed to an inspection station where an eccentricity check is made; the cradle returns to pick up and load the next basket in the welder.

With the improved process, a single operator presses the tube into the basket before the first welding operation; loads the assemblies into one or the other of two identical Progressive welders which comprise the first welding station; and oversees the operation of the automatic Resistance welder at the second welding station—at a considerable saving in labor charge over the older production method.

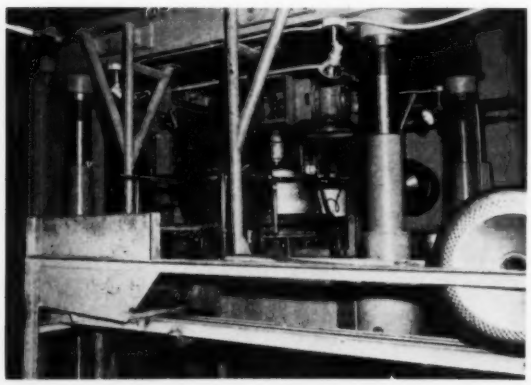
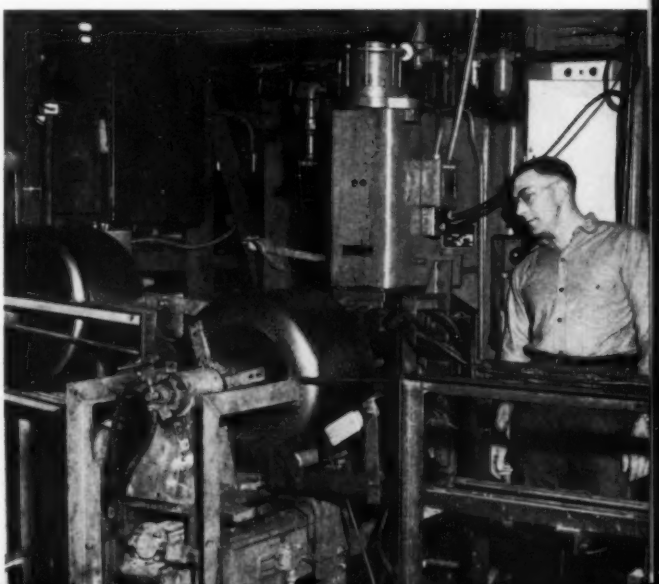


Fig. 2—With tube pressed into basket, assembly is placed bottom-up in first welder for mash welding operation. At subsequent station, part receives second seam weld on automated Resistance welder



HYDRAULIC CONTROL OF AUTOMATIC MACHINERY

SYNTHESIS OF SYSTEMS . . . 6

AUTOMATIC SEQUENCING CIRCUITS

Design of hydraulic circuits to automatically sequence multiple actions of machines may involve more than the establishment of the order in which the actions are to occur. Other considerations can be speed changes, choice of repetitive or nonrepetitive cycles, and whether the actuators are simply to position or are to exert holding loads as well. Circuits which provide these actions are the subject of this sixth part of a series on the synthesis of hydraulic control systems from commercial components.

By **R. HADEKEL**, Engineering Mgr., Sunbury Div., Sperry Gyroscope Co., Ltd., Brentford, England

THERE ARE many kinds of production machines which have to perform operations in a predetermined sequence. The sequence may be established by an operator or it may be produced automatically. Since machines that are sequenced by human operators do not ordinarily require special provisions in their hydraulic circuits, the discussion will cover automatic sequencing systems exclusively.

A sequence may consist of completely cycling one actuator (as in advancing and retracting the piston of a cylinder), or it may involve operating two or more actuators in a given order. At the end of the sequence the system may or may not revert to its original position. The latter condition is relatively rare, but is by no means unknown. In aircraft hydraulic systems, for example, the sequence for operating landing gear may involve the steps of opening the undercarriage doors and extending the undercarriage. Retraction is initiated independently.

If a system does return the actuators to their original positions, the sequence may or may not repeat automatically. If it does, it may continue for a fixed number of cycles or indefinitely until the machine is stopped. In such cases the machine is usually required to complete the cycle in progress before stopping.

Another consideration affecting the design of a sequencing system is whether or not the actuator is required to maintain a load at one of its extreme positions. Die-closing actuators for diecasting machines, for example, must hold the dies closed under load for the full period of the injection cycle; the feed-indexing actuator in a milling or shaping machine, on the other hand, needs only to operate the feed mechanism. The two cases may require different techniques. The provision of means to adjust or limit the strokes of actuators also becomes a factor in the design of some hydraulically operated production equipment.

A special case of the sequence problem is the *Rapid Approach* cycle. A common requirement in many machines, it can be exemplified by the rapid advancement of a drill head from a retracted position to a point just before the drill contacts the work. Upon contact with the work, the tool would then be advanced further on a slower *Feed* cycle.

Other provisions which may be incorporated in automatic sequencing systems include unloading the

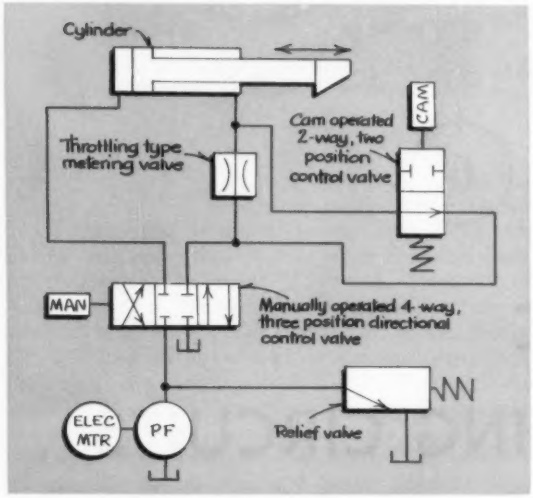


Fig. 55—Graphical diagram for a sequencing system which employs standard hydraulic components to produce *Rapid Approach* and *Slow Feed* action of a piston during its outstroke. Return motion of piston is not regulated.

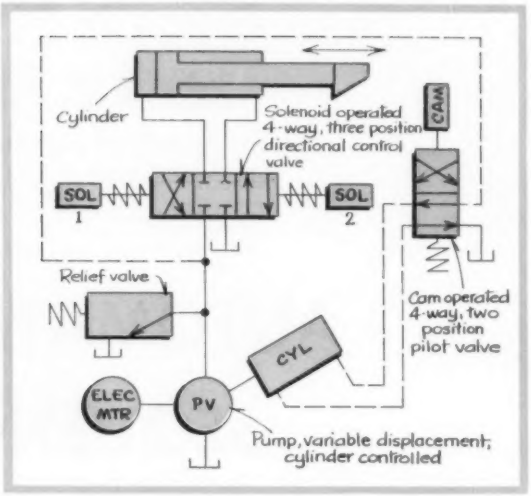


Fig. 56—*Rapid Approach* action of a cylinder may be obtained through use of a variable delivery pump. In this circuit, pump delivery and piston speed are maximum during first portion of outstroke. When cam on piston depresses cam operated pilot valve, control cylinder on variable delivery pump is actuated to reduce pump delivery. Remainder of piston outstroke is at slow speed.

pump at the end of the predetermined sequence, and definite dwell periods between operations.

▶ Use of Timing Devices

It is quite easy to get any type of sequence desired by using timing devices to operate solenoid control valves at preset intervals. A wide range of devices is available including synchronous motor-driven timers which operate groups of contacts and electropneumatic time delay units which employ solenoids and dashpots.

The disadvantage in using timing devices to control sequence, however, is that the system must then be based on a predetermined time interval for each operation. This can rarely be maintained to any degree of accuracy. Time margins, therefore, have to be allowed for actuators to travel to their stops. If the travel of some of the actuators has to be adjustable, the adjustment must also be on a time basis. Accuracy of such an adjustment is difficult to achieve.

Use of timing devices is satisfactory in some non-critical applications such as control of dwell between operations where the danger and consequences of malfunctioning are small.

▶ Rapid Approach Systems

An "approach" portion of the operating stroke of a cylinder, during which the cylinder works against only negligible resistance, is a common feature of many machines. It is an almost universal requirement that this portion of the cycle be carried out at a relatively high speed in order to minimize the total cycle time.

In an operation such as the feeding of a milling table, the speed of the feed cylinder during the working portion of the stroke is determined by machining considerations. This speed is generally set to a value well below the maximum speed obtainable when the full pump power is used. Selection of a pump is based on the power requirements for maximum approach speeds, often with a substantial power margin allowed. A circuit is then devised that will provide a speed reduction during the working portion and avoid this reduction during the approach portion of the feed cylinder stroke.

In contrast, machines of the press type such as riveters, injection molding machines, diecasting machines, etc., generally have working stroke speeds that are as high as can be obtained from the pump. Pumps may be selected arbitrarily or to meet the requirement for an over-all operating speed. Rapid approach may then be obtained by several techniques which will be described. Their success rests on the fact that the approach load is low, so that high speeds are attainable with relatively low pump powers.

It should be noted that in some operations of the press type, such as the closing of dies in injection molding machines, the working stroke is nominally zero. In fact, however, some piston travel is required because of elastic deflection of the machine frame, while in building up to maximum load further motion is needed to compress the oil in the cylinder. If a certain time is specified for building up to load, the required pump power is established.

Several manufacturers offer packaged control units which automatically provide sequences for the above

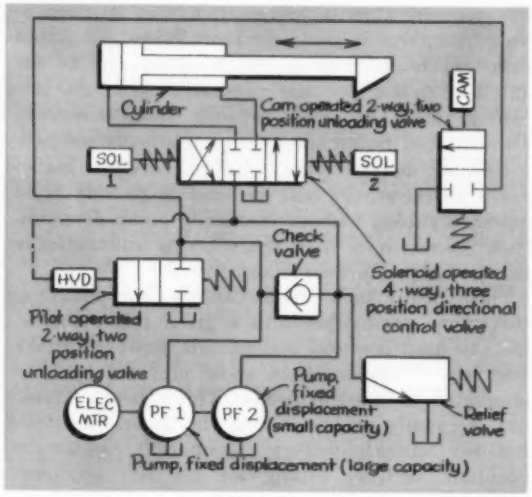


Fig. 57—Cam operated unloading valve is opened by the piston just before piston contacts the work in this circuit. Remainder of piston outstroke is at slow speed determined by delivery of small capacity pump. Return motion is rapid. Pilot operated unloading valve unloads large capacity pump during dwells in work cycle and protects system in the event cam is improperly located on piston.

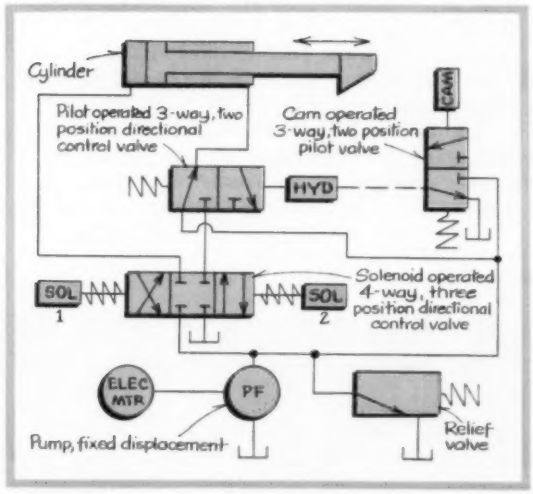


Fig. 58—Differential area operation of cylinder causes rapid approach of piston in this circuit. During first portion of outstroke, system pressure is applied to both ends of cylinder. Pump delivery, therefore, goes into supplying small volume at blind end represented by product of stroke and net effective area of piston rod. Approach speed is rapid. When cam on piston depresses pilot valve, spool of pilot operated control valve shifts and connects rod end of cylinder to tank through directional control valve. Pump must then supply full area of piston at its blind end, and outstroke speed is reduced. Return motion of piston is rapid regardless of position of pilot operated control valve, since rod end is always supplied pressure. Blind end is connected to tank during return stroke.

cases such as *Rapid Approach, Feed,* and *Rapid Return.* Feeding speed may be adjustable, and travel limits of the approach and return strokes can be set by cams on the machine. There may be instances, however, when such packaged control units do not fit the situation, and it is worth-while to examine what can be done with simple standard components.

Standard Components

The circuit of *Fig.* 55 employs an ordinary throttling type metering valve and a standard cam operated control valve to provide *Rapid Approach* and *Slow Feed* control of a cylinder. The return stroke of the cylinder is not speed-regulated. Assuming that the spool of the manually operated directional control valve is in a position to direct oil to the blind end of the cylinder, the piston of the cylinder will advance rapidly until its cam depresses the roller of the cam operated 2-way two position control valve. This valve will close and force the oil exhausting from the rod end of the cylinder to pass through the metering valve.

The resulting restriction in the cylinder exhaust line slows the speed of advancement of the piston until it reaches the end of its stroke. Metering in the exhaust line is desirable if the cylinder is subject to negative loads such as the breaking-through of a drill, in which case throttling the inlet flow would be ineffective. When the manually operated directional control valve is reversed the return stroke of the piston will be rapid.

It is possible to get a similar effect using a variable delivery pump. This arrangement has the advantage that the speed control system does not dissipate power. *Fig.* 56 illustrates what can be done.

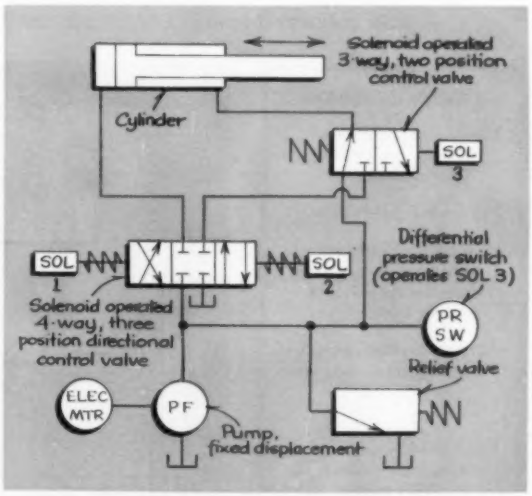


Fig. 59—In this circuit, cylinder is switched from differential to full blind end area operation by a differential pressure switch which operates solenoid of control valve when piston encounters a load.

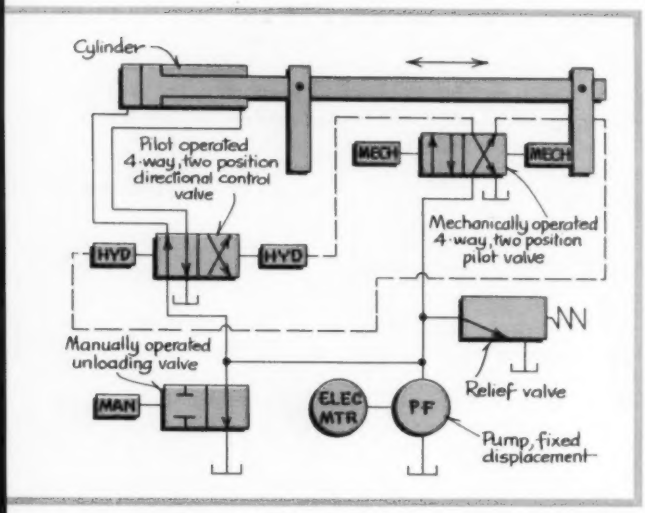


Fig. 60—Continuous reciprocation of a cylinder can readily be effected through pilot valve control. System diagrammed cannot exert a load at ends of piston strokes.

In this circuit, a cam operated pilot valve controls a small cylinder which regulates the delivery of a variable delivery pump. Stops on the cylinder can be set to limit both the approach speed (high pump delivery) and the working speed (low pump delivery).

The principles exemplified in the circuits of *Fig.* 55 and 56 can be extended to cover more complex sequences such as those involving rapid approach strokes of different position and duration, and in both directions.

Twin pump circuits such as the one diagrammed in *Fig.* 46 (See Part 5—AUTOMATION, April 1958) are suitable for use in some rapid approach arrangements. In use, the unloading valve is set to open at a pressure slightly higher than that required to give the approach speed desired. When the piston meets resistance from the work at the end of the approach stroke, pressure rises and opens the unloading valve. The large capacity pump is thereby unloaded and piston speed is automatically reduced.

Variable delivery pumps having constant horsepower characteristics may be used to provide rapid approach strokes without increasing pump demands. Their operation is such that flow is automatically increased as pressure decreases.

Theoretically such pumps can give the minimum stroke time compatible with a given power limitation. In most practical applications, however, stroke times are no shorter than those provided by twin pump systems of equal power. This is because pressure is usually so low during the approach stroke that the variable delivery pump will assume its maximum delivery setting for the full approach period. Variable delivery pumps may have the advantage of shorter working stroke times, but offsetting this would be the higher cost of the pump.

In some cases it is desirable to reduce the speed of a piston before the beginning of its working stroke. This is often required in order to reduce the impact upon contact of the piston or tool with the work. A twin pump arrangement, *Fig.* 57, can be readily devised to perform this function. In this circuit, a cam operated unloading valve is opened just prior to contacting of the work by the rapidly advancing piston or tool. As a result, the large capacity pump is unloaded and the stroke speed is reduced before the work is contacted.

The function of the pilot operated unloading valve shown is to unload the large pump during dwell periods between operating cycles of the machine. It also acts as a safety device to protect the driving motor against overloading in the event the cam on the piston would be incorrectly positioned. This unloading valve is usually an integral part of the

KEY TO CIRCUIT COMPONENTS

V1 - Manually operated 2-way, two position pilot valve.

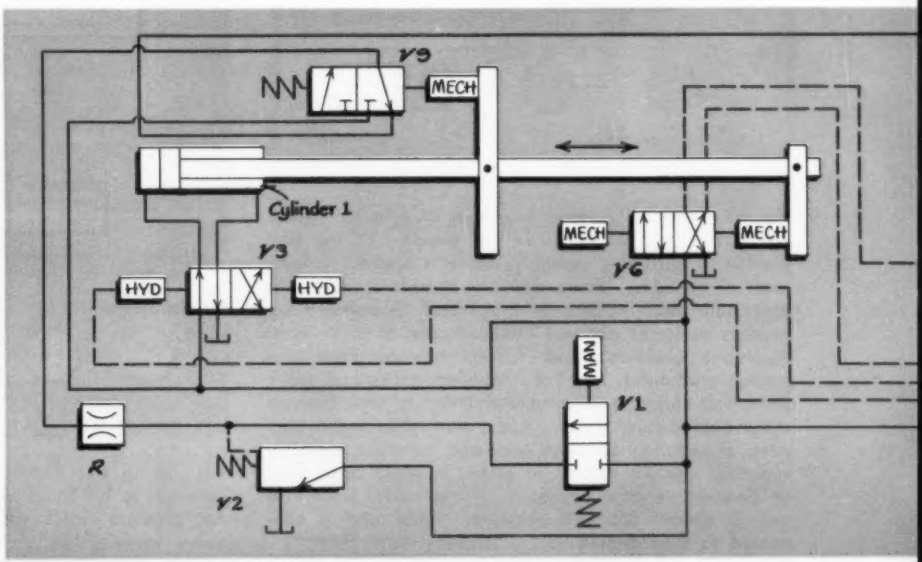
V2 - Vented relief valve.

V3 · V4 · V5 - Pilot operated 4-way, two position directional control valves.

V6 · V7 · V8 - Mechanically operated 4-way, two position pilot valves.

V9 · V10 - Mechanically operated 3-way, two position pilot valves. (spring returned)

R - Restrictor



pump set. If it is of the "vented" type, that is, capable of being overridden by pilot control, then the cam operated unloading valve could be replaced by a less expensive pilot valve. The circuit would be arranged so that this pilot valve would vent the pilot operated unloading valve. Twin pump circuits such as the one described automatically provide rapid return action.

If, as is usually the case, pressure is applied to the rod end of the cylinder to provide return action, motion can be speeded up by choosing a cylinder with a relatively large diameter rod. Since this increases the pressure required during the return motion, the rod must not be so large in diameter as to cause unloading of the larger pump.

Differential Cylinder Action

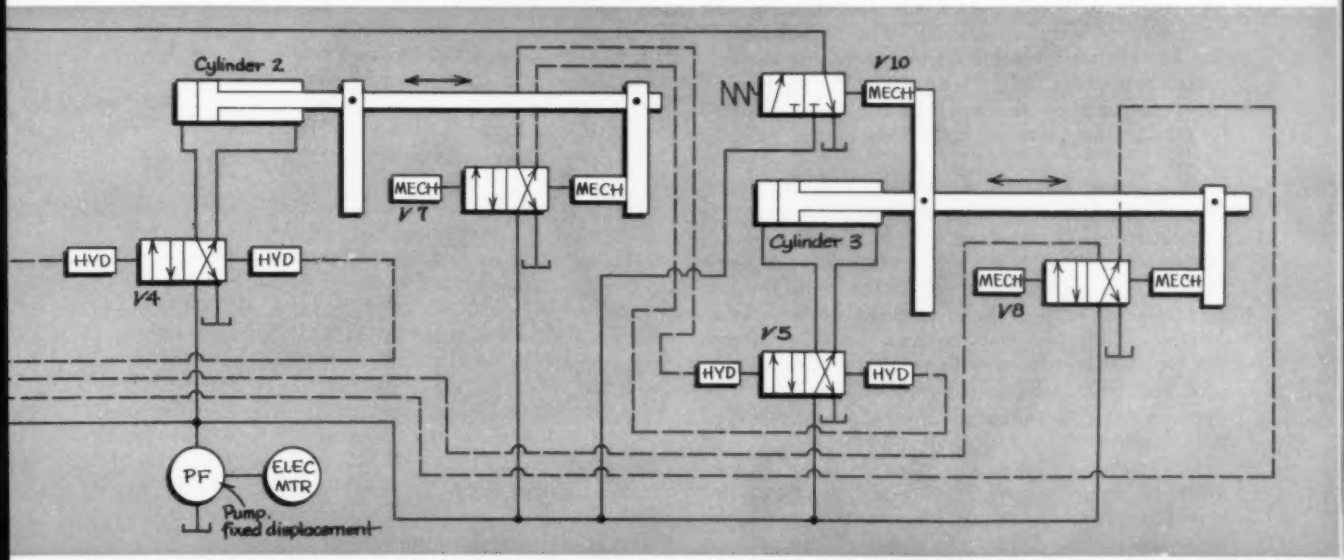
An inexpensive and quite effective way of achieving *Rapid Approach* of a cylinder is to make the cylinder operate differentially during its approach stroke, that is, on the effective area of its piston rod. A simple position-controlled system of this type is shown in *Fig.* 58. With the spool of the directional control valve in a position to direct oil to the blind end of the cylinder, system pressure will also be applied to the rod end through the pilot operated valve. The piston thus extends rapidly on the basis of blind end pressure acting on the net effective area of the piston rod. When the piston extends sufficiently for its cam to depress the cam operated pilot valve, the pilot operated control valve will be reversed. The rod end of the cylinder will then be connected to tank through the directional control valve. This exposes the full area of the piston to pressure in the blind end of the cylinder, and forward motion is slowed. Note that during the return stroke of the piston the position of the pilot operated control valve is immaterial, since the rod end of the cylinder is always connected to pressure when *SOL* 1 is energized. The blind end of the cylinder is connected to tank through the directional control valve at this time.

Similar systems, but which depend on load rather than on position, are feasible provided due account is taken of the fact that pressure will drop when the cylinder is switched from differential to full blind end area operation. One way of overcoming this effect is illustrated in *Fig.* 59. In this circuit, a solenoid operated control valve is actuated by a differential pressure switch. To insure positive operation, the ratio of operating to resetting pressures of the differential switch must be greater than the ratio of full and annular areas of the cylinder.

In differential operation of cylinders, the pump need supply only the volume displaced by the piston rod. The remainder of the volume required to fill up the "full area" side of the cylinder at its blind end is supplied by oil circulated from the rod end. In many press applications this technique is inapplicable because the loading member is a single acting cylinder.

If such a press is of the downstroking type, rapid approach may be obtained by allowing the platen to fall of its own weight. Alternatively, and this applies to both upstroking and downstroking presses, separate small cylinders may be provided for rapid approach. In either case, nothing would be gained unless the main cylinder gets filled with oil during the approach stroke. This may be done by connect-

Fig. 61—This automatic sequencing circuit causes advancement of cylinder 1, 2, and 3 in order, followed by retraction in same order. Manually operated pilot valve V1 must be depressed to initiate each cycle. When this valve is released, machine will complete the cycle in progress and stop.



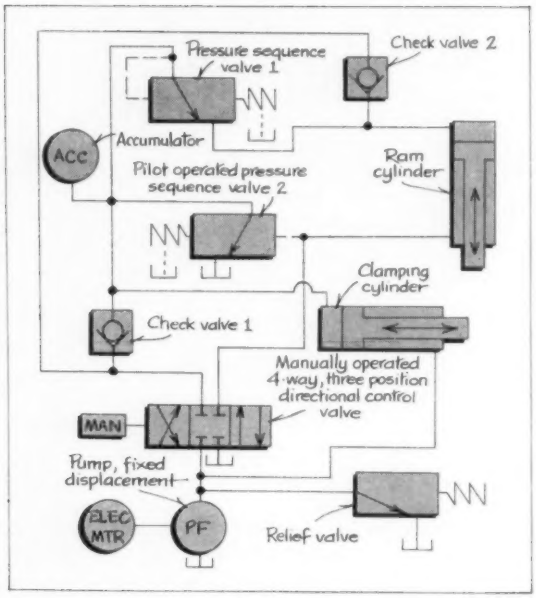


Fig. 62—Use of pressure operated sequence valves allows cylinders to sustain loads at the ends of their strokes. In this circuit, the clamping cylinder extends and exerts force before the ram lowers. It continues to clamp until after the ram is fully retracted, then it retracts.

ing the main cylinder to tank through large bore piping and an automatic prefiller valve. It is not always necessary in this case to have the tank higher than the cylinder—atmospheric pressure will do the job of filling the cylinder if the system is correctly primed.

▶ Reciprocating Cycles

One of the simplest automatic cycles is the continuous to-and-fro motion of a cylinder as might be employed, for instance, in reciprocating the worktable of a surface grinder. The required effect can be very simply achieved by controlling the cylinder through an ordinary directional control valve. Stops or cams on the machine could be arranged to reverse the valve at both ends of the cylinder stroke.

In practice, however, certain refinements of this simple arrangement are usually required owing to a difficulty which arises in most automatic sequencing systems. That is, as the control valve is being actuated by the cylinder, the latter tends to stop, and reversal of the valve may not be completed. Mechanical devices such as over-center or toggle devices have been used with varying degrees of success, and more complicated mechanisms have been used in some aircraft applications. An easier solution, however, is to use pilot valve control.

Continuous reciprocation of a cylinder is provided by the pilot valve circuit of *Fig.* 60. In this system, operation is started by manually closing the unloading valve. When the piston of the cylinder advances sufficiently for a stop on the piston to operate the pilot valve, this valve is reversed and causes reversal of the pilot operated directional control valve. The piston then retracts until another stop on the piston operates the pilot valve in the opposite direction. Releasing the unloading valve stops the system.

Success of this circuit lies in the fact that the directional control valve is not reversed by pilot pressure from the pilot valve until the latter has passed its neutral point. In the meantime, full pressure is being maintained to advance or retract the cylinder. Also, pilot valves of the type used require only small travels to be reversed.

Pilot valve systems can be extended to cover more complex actions of reciprocating cylinders. For example, the circuit of *Fig.* 61 causes advancement of cylinder 1, 2, and 3 in sequence, followed by retraction of cylinder 1, 2, and 3 in order. Upon completion of the reverse stroke of cylinder 3 the action stops unless manually operated pilot valve *V*1 is held depressed.

Operation is as follows: Manually operated pilot valve *V*1 is depressed, which places the same pressure on the "vent" connection of vented relief valve *V*2 as this valve has on its inlet connection. *V*2 then functions as an ordinary relief valve and system pressure builds up. Oil is thereby admitted through directional control valve *V*3 to the blind end of cylinder 1 and its piston advances.

As the piston of cylinder 1 moves to the right, a stop on the piston withdraws from pilot valve *V*9 so the spring on *V*9 can shift this valve to its unoperated position. Thus, the passage to tank for the vent connection of *V*2 through restrictor *R*, *V*9, and pilot valve *V*10 is blocked. Instead, system pressure is applied to the vent connection of *V*2 through *V*9 and *R*. *V*1 can now be released without stopping the cycle.

At the end of the advance stroke of cylinder 1 a stop on the piston contacts and reverses pilot valve *V*6. This action admits pressure to the lefthand pilot of directional control valve *V*4 and connects its righthand pilot to tank. Valve *V*4 is thus shifted to a position admitting pressure to the blind end of cylinder 2 and connecting its rod end to tank, and cylinder 2 advances. At the end of the advance stroke of cylinder 2, a stop on the piston contacts and reverses pilot valve *V*7. This operates directional control valve *V*5 through its pilots, and cylinder 3 advances.

At the end of the advance stroke of cylinder 3 a stop on the piston contacts pilot valve *V*8 and shifts its spool to the right. By this action system pressure is placed on the righthand pilot of directional control valve *V*3 for cylinder 1, and its lefthand pilot is connected to tank. The consequent shifting of the spool of valve *V*3 is in a direction to retract the piston of cylinder 1.

Upon return of the piston of cylinder 1, a stop on the piston shifts the spool of *V*6, and through the consequent shifting of *V*4, cylinder 2 will return. Another stop on the piston of cylinder 1 depresses pilot valve *V*9. However, pressure is maintained to the vent connection of *V*2 through *V*10,

$V9$, and R so that the pump will remain on load.

At the end of the return stroke of cylinder 2 a stop on the piston contacts and reverses $V7$. This results in shifting of the spool of $V5$ in a direction to return cylinder 3. Upon return of cylinder 3, valves $V8$ and $V10$ are operated. $V8$ connects the lefthand pilot of $V3$ to pressure and its righthand pilot to tank. $V10$ unloads the pump by opening a path from the vent connection of $V2$ to tank through R, $V9$, and $V10$. The cycle stops until $V1$ is again manually operated.

Maintaining A Load

Sometimes it is necessary that a cylinder which has completed its stroke remain under load. Requirements of this type arise in injection molding and diecasting machines, for example, where the load on the dies must be maintained during injection or casting. It is also frequently necessary to sustain forces on gripping devices used in machines.

This cannot be realized with the systems described in *Fig.* 60 and 61, since operation of any cylinder in either direction would cause a system pressure drop that would reduce the forces exerted by any fully advanced cylinder. In any event, if the cylinders in these circuits are to operate pilot valves at the ends of their strokes, they cannot also exert loads.

A circuit for a manually operated press, *Fig.* 62, illustrates how sequencing can be accomplished under load through use of pressure operated sequence valves. When the directional control valve is shifted

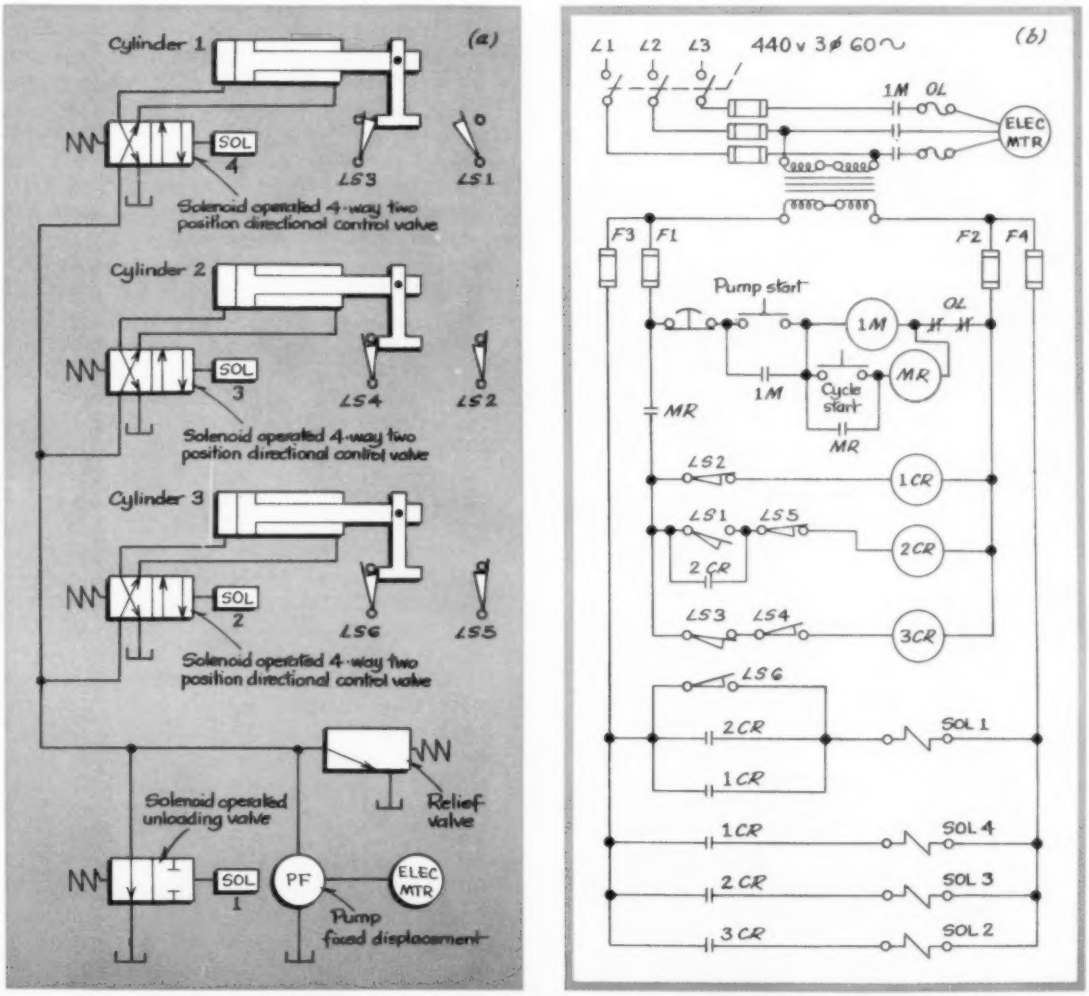


Fig. 63—Complex sequences may conveniently be controlled by electrohydraulic means. This circuit advances and retracts the pistons of three cylinders in the order: Advance cylinder 1, advance cylinder 2, retract cylinder 1, advance cylinder 3, retract cylinder 2, retract cylinder 3. Other sequences can readily be provided using limit switches, relays, and solenoid operated hydraulic valves.

manually to the proper position, oil will flow to the blind end of the clamping cylinder through check valve 1, overcome rod end pressure, and the piston of the clamping cylinder will extend. When clamping is effected, system pressure will rise and open pressure sequence valve 1, admitting oil to the blind end of the ram cylinder. The piston of this cylinder will extend.

When the spool of the directional control valve is shifted to its return position, oil is admitted to the rod end of the ram cylinder and its piston rises. Exhaust from the blind end to tank is effected through check valve 2 and the directional control valve. Fluid from the accumulator, trapped by check valve 1, keeps the clamping cylinder extended and under load.

Pressure rise which occurs when the ram cylinder reaches its fully retracted position then operates pilot operated pressure sequence valve 2 and the piston of the clamping cylinder retracts. The settings of pressure sequence valves 1 and 2 must be carefully adjusted in order to prevent their premature operation.

Complex Sequencing Cycles

Automatic sequences are difficult to achieve by purely hydraulic means where the cylinders do not advance and retract in the same order. The simple systems just described are then no longer generally applicable except in a few special cases. One such special case would be the sequencing of all cylinders forward in a given order, followed by return motion in another order. The number of valves required is very large, however, and it is doubtful if this method of approach is worth-while.

A still more difficult case is the arbitrary sequence in which a cylinder may have to reverse before another cylinder advances. As an example, suppose the sequence would be: Advance cylinder 1; advance cylinder 2; retract cylinder 1; advance cylinder 3; retract cylinder 2; and retract cylinder 3. A sequence of this kind could be provided by using a hydraulic equivalent of the electrical relay which has multiple contacts including holding contacts. While this is technically feasible, suitable valves with such characteristics are not generally available. The usual, and simplest, solution is to use solenoid operated hydraulic valves in combination with electrical relays and limit switches.

An example of a circuit of this type is shown in *Fig.* 63. It sequences three cylinders in the order just mentioned.

Momentary operation of the *Pump Start* button, *Fig.* 63(*b*), energizes the coil of relay 1*M* and the pump motor starts. It is maintained in operation by holding contact 1*M* across the *Pump Start* button. Output of the pump is diverted to tank through a normally open unloading valve, *Fig.* 63(*a*). When the *Cycle Start* pushbutton is momentarily depressed, the coil of relay *MR* is energized and held by contact *MR* bridging the *Cycle Start* button. Another contact of relay *MR* supplies voltage to the control relay circuit. Because limit switch *LS*2 is normally closed, the coil of relay 1*CR* will be energized. A contact of relay 1*CR* thus actuates *SOL* 1 to close the unloading valve and another 1*CR* contact actuates *SOL* 4. The latter action causes the spool of the directional control valve for cylinder 1 to shift to a position admitting pressure to the blind end of cylinder 1 and connecting its rod end to tank. The piston of cylinder 1 thus extends.

At the end of forward travel of the piston of cylinder 1 a stop on the piston closes normally open limit switch *LS*1. This energizes the coil of relay 2*CR*, which remains energized through holding contacts 2*CR* as long as normally closed limit switch *LS*5 is closed. Operation of relay 2*CR* closes contacts in the circuits of *SOL* 1 and *SOL* 3. When *SOL* 3 is energized, the spool of the directional control valve for cylinder 2 is moved to a position directing oil to the blind end of cylinder 2 and connecting its rod end to tank. The piston of cylinder 2 extends.

When the piston of cylinder 2 is fully extended it opens normally closed limit switch *LS*2 and the coil of relay 1*CR* is de-energized. *SOL* 4 is thus de-energized and cylinder 1 retracts. Since *SOL* 1 is kept energized by a closed contact of relay 2*CR*, the unloading valve remains closed.

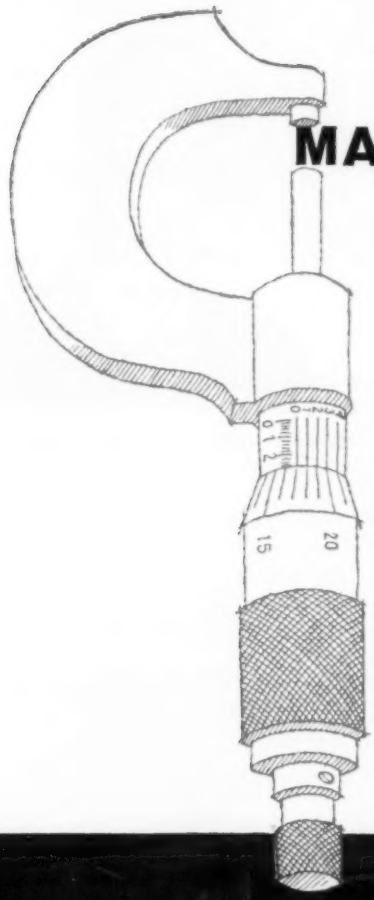
Full retraction of cylinder 1 closes normally open limit switch *LS*3. Normally closed limit switch *LS*4 is closed at this time because cylinder 2 is extended. The coil of relay 3*CR* is thus energized, and contacts 3*CR* in the circuit of *SOL*2 thereby close. When *SOL* 2 is energized the spool of directional control valve for cylinder 3 is shifted to a position admitting oil to the blind end of cylinder 3 and connecting its rod end to tank. The piston of cylinder 3 extends.

As the piston of cylinder 3 extends, limit switch *LS*6 is allowed to adopt its normally closed position. When the piston is fully extended, a stop on the piston opens normally closed limit switch *LS*5 and the coil of relay 2*CR* is de-energized. Cylinder 2 thus retracts because *SOL* 3 is de-energized by the opening of contacts 2*CR*. The unloading valve remains closed, however, because *LS*6 is closed, maintaining a circuit to *SOL* 1.

When cylinder 2 is fully retracted, normally closed limit switch *LS*4 is opened and the coil of relay 3*CR* is de-energized. This opens the circuit to *SOL* 2 and the piston of cylinder 3 retracts. When cylinder 3 is fully retracted *LS*6 is opened, de-energizing *SOL* 1, and the system is unloaded.

This circuit has been presented as an exercise in building up complex sequence systems, and is not necessarily complete. In particular, it would be desirable in practice to include safety contacts to take care of the possibility of the system being in the wrong configuration at starting.

Seventh and final part of this series, to cover hydraulic and electrohydraulic servo systems, will appear in the August issue.



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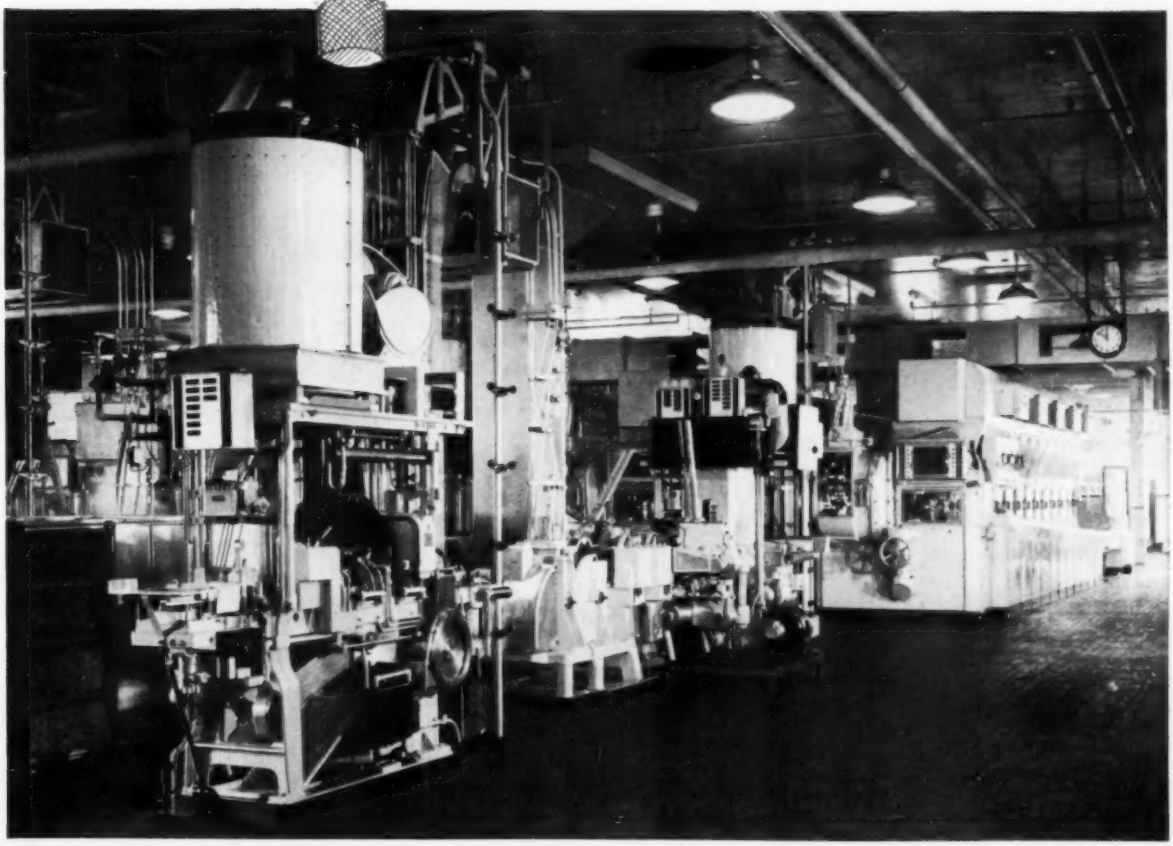
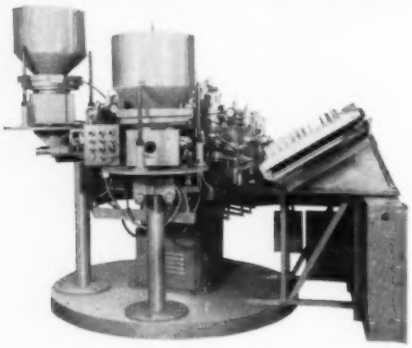
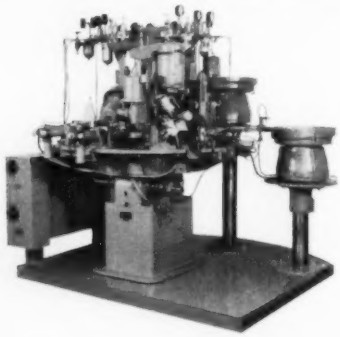
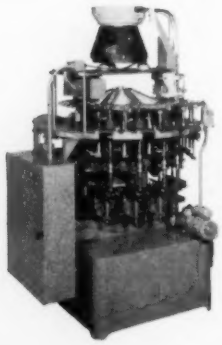


Circle 673 on Page 139

Practically Speaking . . .







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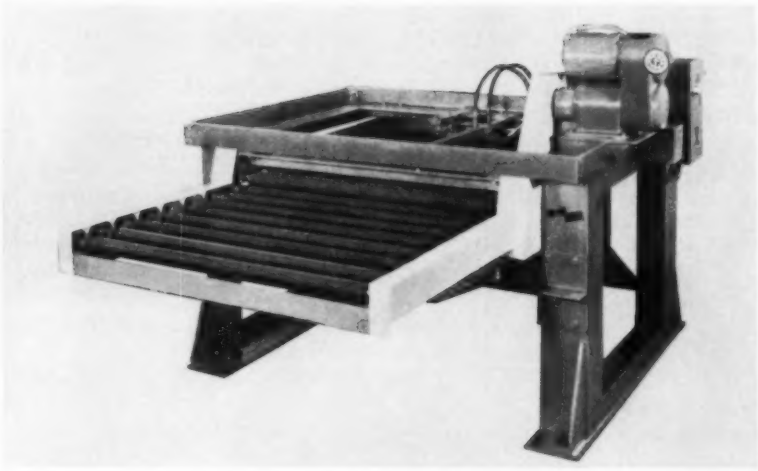


Resilient Magnetic Rolls Handle Parts

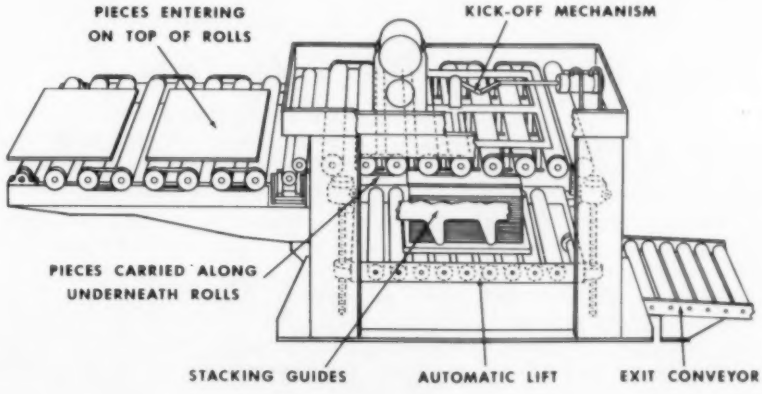
DENMAG, a material which acts like a magnet, is produced by compounding neoprene or other rubber or plastic substances with various permanent magnetic materials of small particle size. Developed by **Herr Equipment Corp.**, 1403 Vine St., Warren, Ohio, the product can be compounded to provide strong or weak magnetic fields, as required by individual applications in the metal producing, metal processing, and metal fabricating industries. The magnetic particles can be applied in a variety of patterns to facilitate handling and tracking. For instance, a roll can be treated so the magnet forms a straight or spiral pattern, with nonmagnetic sections between, so the pieces handled are tracked and guided properly.

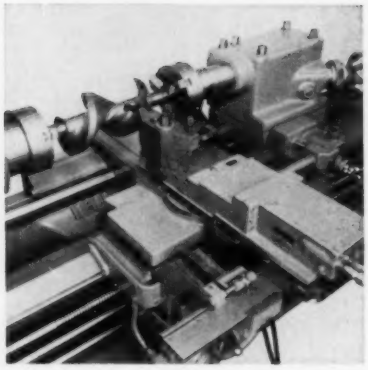
When used for parts-handling rolls, the material can be compounded to provide a low density magnetic flux over a large area and thus exert an even, gentle force.

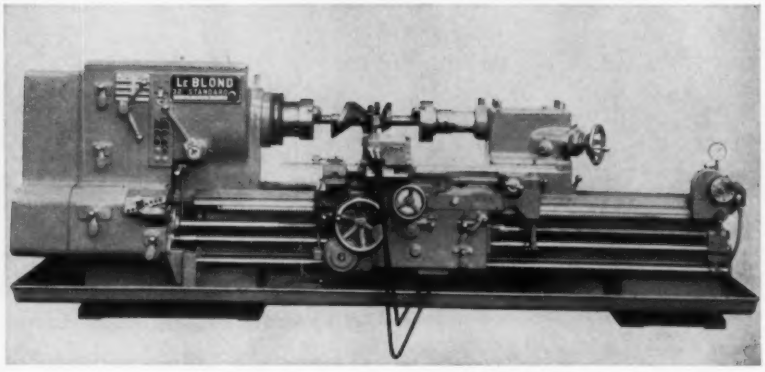
As shown in the photo, the rolls are attached to a company automatic stacker and feeder. The unit can handle any square, rectangular, circular, oval, elliptical, trapezoidal, or odd-shaped piece. Since it does not use pinch rolls, there is no damage, scratching, or marring of the surfaces of the pieces handled. When used for stacking, the pieces from the stamping, punching, notching, cutoff or other machine are received and carried along the top of the covered entry rolls. The pieces then pass underneath the stacking rolls. Each piece is tapped lightly from above, just as it contacts the back plate, to release it from the magnetic field. Freed parts drop between adjustable side guides and are stacked neatly and accurately, regardless of size or shape, on an automatic lowering platform for removal with a lift truck or delivery to a conveyor. Two or more machines can be mounted in tandem, and their operation interlocked, to provide continuous operation. Operating speeds of 150 fpm are attainable.

Feeding is accomplished in reverse order. Each piece is lifted off the stack with vacuum cups, carried across the underside of the first set of covered rolls, then across the top of the next set of rolls, and guided accurately into the feeding mechanism for the next operation.

Circle 401 on Page 139







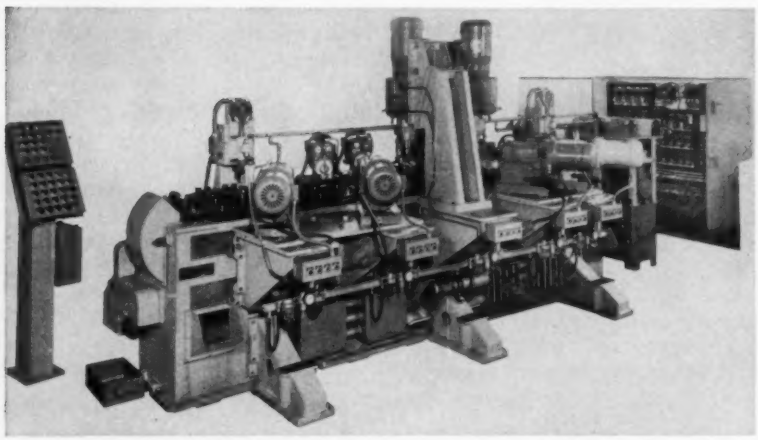
Lathe Chases Concave and Convex Contours

Item 402

Equipment automatically machines concave and convex contours on a spiral shaped part. A tracer unit is used to position the tool for each successive cut. Tool cutting motion is accomplished by chasing the spiral in the same manner that threads are chased. The carriage is synchronized with the spindle, and mounted on the carriage is a cross slide which automatically provides in-and-out tool motion for tool clearance of up to $\frac{3}{8}$-inch during the return motion of the carriage. Each feeding of the length slide moves the tracer stylus slightly along the curved template, which positions the tool for the next cut. Feeds to 0.070-inch are available.

A tool release mechanism and a cycling unit which is built into the machine provide automatic operation once setup is made. One rotor that is being machined has a 10-inch lead and is concave on one side and convex on the other side. The workpiece is clamped by three-jaw chucks in both the head and the tailstock. A special work driver and locating pin arrangement keeps the workpiece from slipping while under cut, preventing any change in the relationship of tool and workpiece. Normally the cut on this left-hand rotor is taken from headstock to tailstock. The mating righthand rotor is machined from tailstock to headstock. **R. K. LeBlond Machine Tool Co.**, 2684 Madison Rd., Cincinnati 8, Ohio.

Circle 402 on Page 139



Transfer Unit Machines and Probes Parts

Item 403

Unit is designed to completely machine and probe parts having multidirectional operations performed on them. The machine, which can be tooled for more than 20 machining operations, can process parts of all kinds such as extrusions, die castings, sand castings, and forgings. The machine bed is 12 feet long, machined and T-slotted on both sides to receive sliding tables. The machining units and columns are directionally mounted on these tables.

In operation, the parts are loaded at one end, indexed to the hydraulic fixture locking position, indexed through the various work and probe stations, and hydraulically unlocked, washed, air-dryed and ejected. The interchangeable pallet and fixture assemblies are indexed rapidly from station to station by a Geneva mechanism. A hydraulic unit supplies power for pallet hold-down, shot-bolt operation, and fixture locking and unlocking functions. A built-in coolant system provides sufficient liquid to cool the operating tools and wash the chips into a motorized conveyor. The conveyor screw carries the chips toward both ends of the machine for removal. **Jeffrey Machine Tool Div., Jeffrey Die & Engineering Inc.**, 23281 Telegraph Rd., Detroit 19, Mich.

Circle 403 on Page 139

Weight Checker

Item 404

Electronic checkweigher classifies packages by weight at speeds up to 200 per minute with an accuracy of acceptance of $\pm 1/64$ of an ounce. In operation, a polyester belt is driven at a constant speed over a platform that is attached to an electronic weighing head. Photoelectric cells control the sequence of

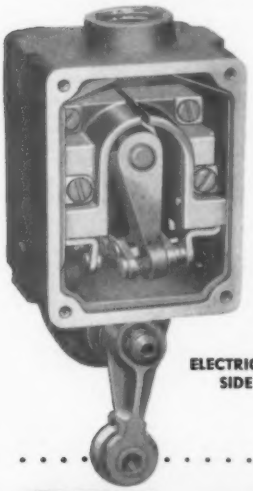
PROVED...by millions of contacts

NATIONAL ACME
SNAP-LOCK
TRADE MARK

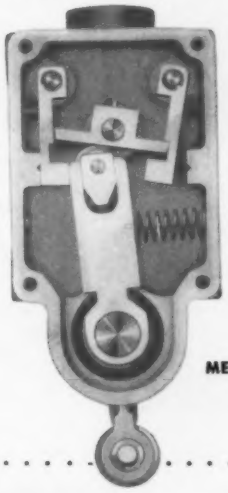
As illustrated below, National Acme SNAP-LOCK Limit Switches employ a basically simple yet positive *snap-action* locking mechanism—with extremely few moving parts. Thus wear is reduced to a minimum and dependable trouble-free service, far beyond normal limits, is assured.

The double-throw contact lever, connected directly by shaft with the latch bar, carries self-wiping coin silver contact points to assure quick action make or break—reducing wear ever further.

Electrical and mechanical sides are separated by a wall within a sturdy die-cast housing which is fully insulated and is dust and oil resistant. Can also be furnished water- and oil-tight.



ELECTRICAL SIDE



MECHANICAL SIDE

THE ORIGINAL
SNAP-ACTION LOCKING SWITCH

SNAP-LOCK LIMIT SWITCHES. Made in single-pole and double-pole series, in four types: Standard, Short Travel, Neutral Position and Push Lever. With the exception of the Push Lever Switch, all are adaptable to special enclosures for hazardous location service and may be used with various styles of operating levers. For AC or DC service.

and now . . .

a new design concept for **CONTROL STATION SWITCHES**

the heavy-duty . . . oil, water, dust tight **GOLD-N-RING**

made by machine tool builders to machine tool specifications

Heavy duty silver-alloy contact points provide maximum electrical capacity, long life.

Heavy duty terminal screws have ⅛" thread contact to prevent stripping during installation and permanently secure wires for continuous, trouble-free service.

Single or double-pole contact block assemblies—can be used interchangeably with several types of GOLD-N-RING push button and selector operator heads.

Rated for 600 volts—AC or DC. Meets all Joint Industry Committee and National Machine Tool Builder's Association requirements.

Protected against oil and water seepage in operator head by Sealtight oil-resistant rubber diaphragm.

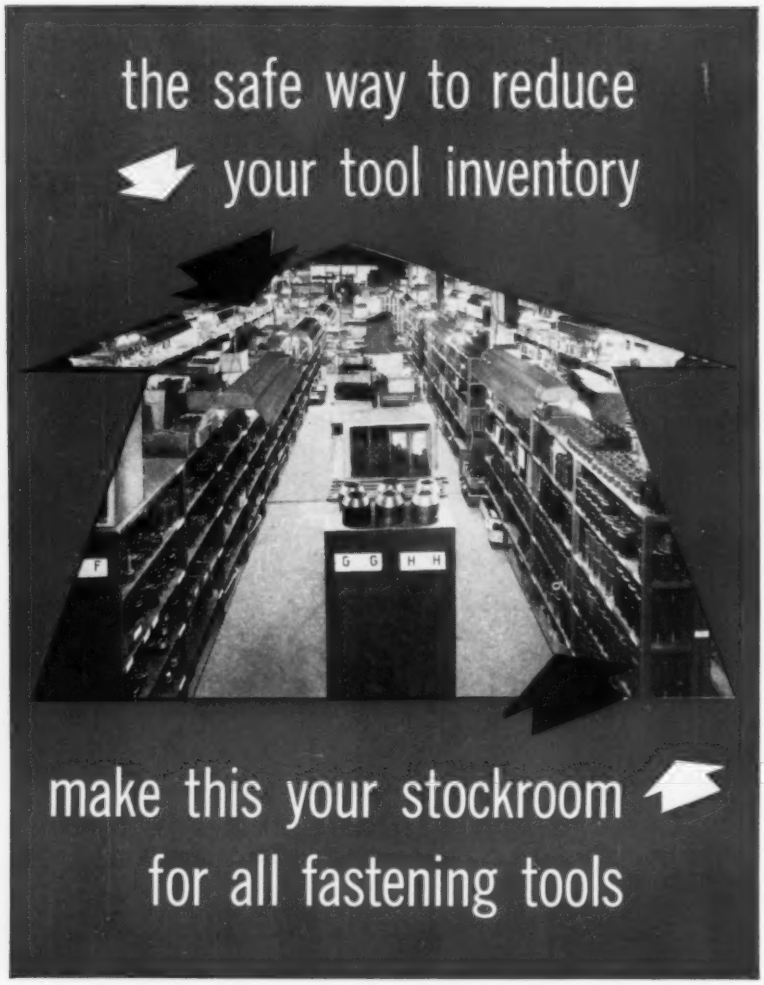
Easily replaces existing switches.

ELECTRICAL MANUFACTURING DIVISION

the National Acme company

196 EAST 131st STREET, CLEVELAND 8, OHIO

Circle 675 on Page 139



There are more than 5,000 stock types and sizes of nut running tools in the Apex stockrooms . . . and almost as many types and sizes of screwdriving tools. Apex—the authority on fastening—can supply the tools you need, when you need them.

Prompt delivery can be made on standard tools . . . immediate attention is given to specials. For rush emergency orders, Apex representatives in many principal cities maintain sizable stocks of the most used fastening tools.

Want to see what's in "your fastening tool stockrooms"? Write, on your company letterhead please, for Catalog 29-R—Nut Running Tools; Catalog 21—Screwdriving Tools; or Catalog 25—Magnetic Fastening Tools.

1933 *A Quarter Century of Service to Industry* **1958**

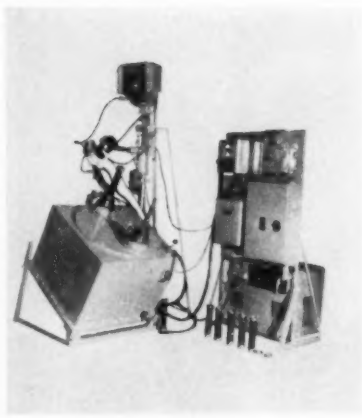
THE APEX MACHINE & TOOL CO.
1036 S. Patterson Blvd.
Dayton 1, Ohio

TOOLS FOR
screwdriving
nut running
FASTENING

Circle 676 on Page 139

the weighing operation, automatically meeting the varying output of the infeed conveyor. The sensitive weighing head transmits a signal that actuates the segregation gate. Packages that are underweight are rejected from the conveyor belt, overweights are shifted to one side, and the packages that are within the acceptance range pass straight through. Other segregation patterns can be made to meet specific requirements. A servo control unit that works in conjunction with the checkweigher is available. The servo translates package weight variations into automatic filler adjustments when a definite variation trend to heavy or light is established. **Bartelt Engineering Co.**, 1900 Harrison Ave., Rockford, Ill.

Circle 404 on Page 139



Automatic Welder

Item 405

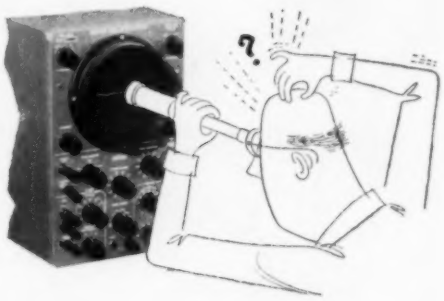
Unit is capable of automatically welding collars on each end of a tube at the rate of 360 welds an hour. Welding unit is a General Electric inert arc type, using 0.045-inch wire type electrode at 72 inches

JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

WHEN A SIGNAL ALMOST ISN'T...

We feel like passing out cigars because our development engineers have given birth to a new addition to the CONTROL standard line of proportioning reactors that never wear out. It's a pre-amplifier that will work from a 200-microwatt signal, with a 3-cycle response. Hitch it to a CONTROL proportioning reactor and in one step you have wide range control of a 2-KVA load. That means if you have to work from the minute output of a small tach-generator, thickness gauge, electronic relay or process control instrumentation, you should write us. *We've got CONTROL pre-amplifier specifications ready for you.*



THE HECK WITH MAINTENANCE!

There are no moving parts in a CONTROL proportioning reactor. There are no filaments to burn out. There are no adjustments to make. You can bury them, fly them through the troposphere, or install them in the corrosive atmosphere of a chlorine plant—it makes no difference. If you're tired of control equipment that has to be pampered with maintenance, you're for us. Servicing? Parts replacement? No more, friend, no more. We're better than hormones for the pooped-out control engineer. *Why not write us your troubles?*

DESIGN CONTROL CIRCUITS WITH BUILDING BLOCKS...

When we took "never wear out" magnetic devices into the industrial control field, we made the grand plunge—designed standard lines which a systems engineer could design into his equipment right from the CONTROL catalog. That put an end to the high price of the unusual advantages of saturable reactors. Instead of custom designing, we mass produce—and your costs come tumbling down. *Want to select the building blocks to design your control circuits? We have information on CONTROL'S standard proportioning reactors—theory, characteristics, typical uses. It awaits your letter.*

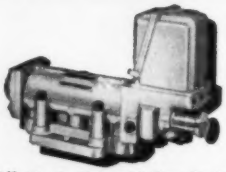
Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.
DEPT. A-50, BUTLER, PENNSYLVANIA

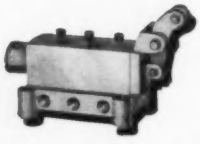
Circle 677 on Page 139

Get more production—at lower cost with

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

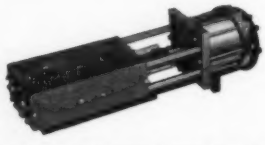


½" Single Solenoid Two Position 4-way "B"-type Valve, for Pressures up to 250 psi.



¼" 4-way Cam Operated Spring Return Valve, for Pressures up to 125 psi.

½" 2 Pedal Foot Operated 4-way Valve, for Pressures up to 200 psi.

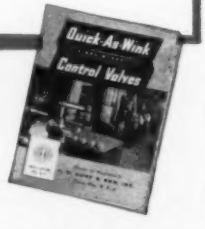


1" Pilot Cylinder Operated 4-way Two Position Hydraulic Valve, for Pressures up to 5000 psi.

Cut your costs—and increase your production—by installing Quick-As-Wink Control Valves **throughout your plant.** Proven in service, our exclusive, patented* construction assures year after year of long, efficient, dependable **and low cost operation.** Production and maintenance men know Quick-As-Wink Valves are unsurpassed. Can you afford to gamble with less? Hundreds of different types, actions and sizes from ¼" to 4". Get full details.

*U. S. Patent No. 2,645,450

Write for* BULLETIN NO. 571 *Today.

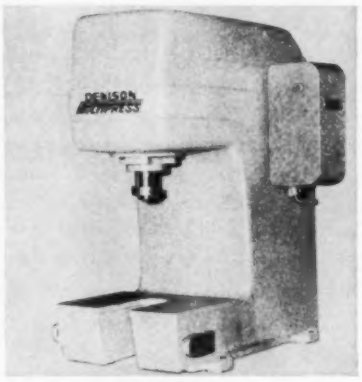


Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

***Mfd. by* C. B. HUNT & SON, INC., 2073 East Pershing St., Salem, Ohio**
— Engineering and Sales Representatives in the Principal Cities —

per minute. When used as a multiple station indexing plate, with interchangeable fixtures, several different operations can be performed with the basic machine. **Tri-City Tool & Machinery Corp.**, P. O. Box 404, Rock Island, Ill.

Circle 405 on Page 139



Hydraulic Press

Item 406

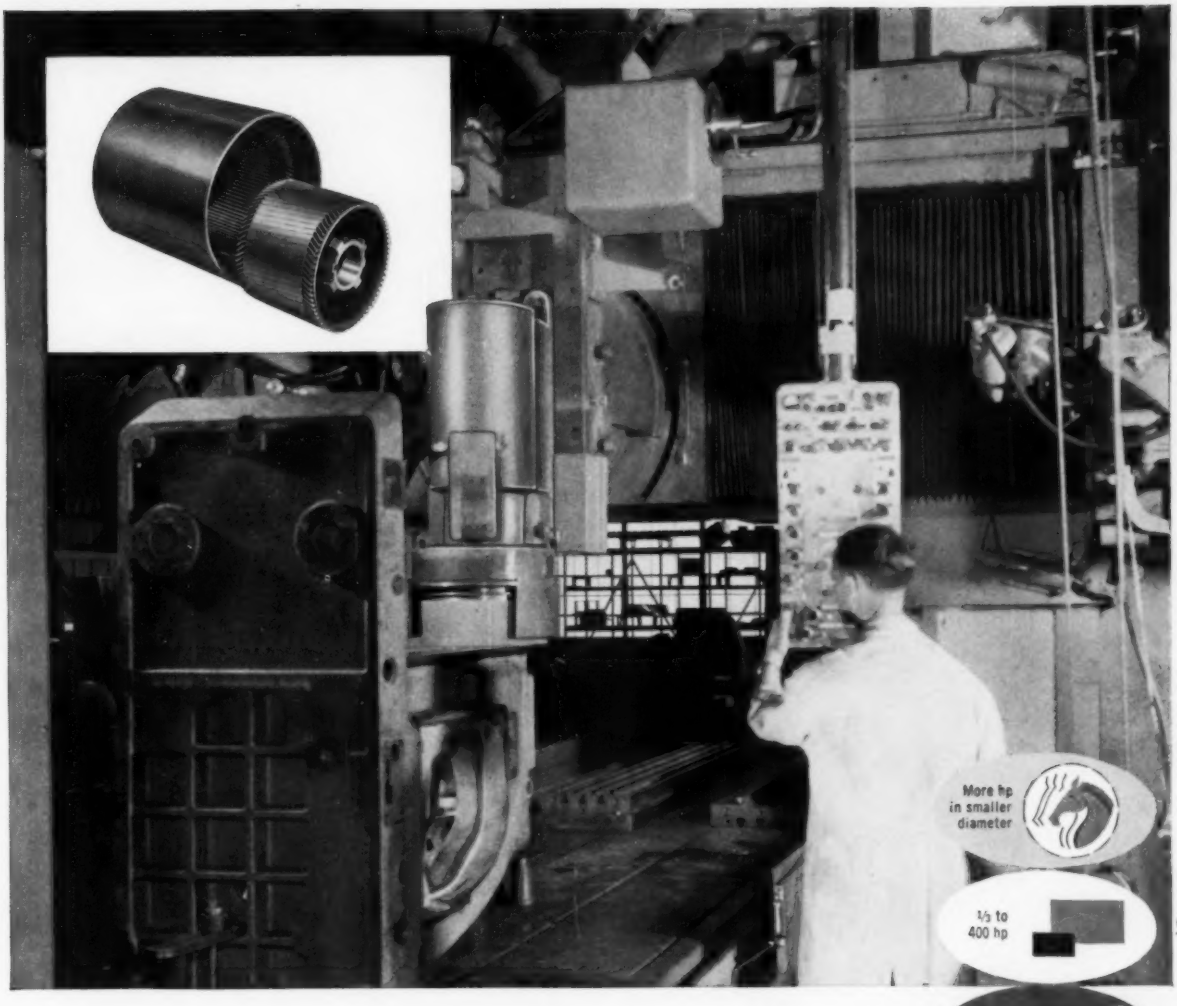
Press can be incorporated as a unit in an automated production system to handle a variety of small parts forming and assembling operations such as riveting, punching, marking, trimming, pelleting, compacting, and testing. The press is available in one and two-ton capacity. The ram pressure on the one-ton unit (shown) can be set from 500 to 2000 lb. The two-ton unit can be set from 500 to 4000 lb ram pressure. A dual control system insures safety as the unit will operate only when both hands are on the actuating buttons. **Denison Engineering Div., American Brake Shoe Co.**, 1160 Dublin Rd., Columbus, Ohio

Circle 406 on Page 139

Printed Circuit Press

Item 407

Unit is capable of producing printed circuits on rigid base mate-



This motor can be built-in!

Louis Allis rolled-shell shaftless motors provide compact, close-coupled power for machine tools

Here's just one of many Louis Allis special motor designs that machine tool builders respect and users appreciate. It's a 30 hp, 1200 rpm rolled-shell shaftless motor — pioneered by Louis Allis.

The motor consists of a precision stator in a steel shell and an accurately machined rotor that can be mounted directly on machine tools like the rotary surface grinder shown above.

The compact motor allows closer spacing of spindles and shafts. It reduces the weight and size of the machine — blends the motor into the machine contour. Its design flexibility enables you to use direct drives for separate machine functions — to select motor characteristics best suited for each operation.

Louis Allis rolled-shell shaftless motors range in size from ⅓ to 400 hp. They can be furnished with high torques, low losses for grinder duty, vibration-free operation, and other special modifications. For more information — for engineering assistance — call your Louis Allis District Office. Or write The Louis Allis Co., 463 E. Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

SM-107

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 679 on Page 139

rial up to 3/4 inch in thickness. The translucent vacuum bed is illuminated from below for quick visual registration with prepunched boards, and has a capacity of 200-225 impressions per hour.

The dry screen process is based on printing a thermoplastic resist through a heated screen. On contacting the cooler copper surface of the laminate, the resist dries instantly in the precise design on the stencil. The panels can be freely handled, stacked, punched, or etched as quickly as they can be removed from the press. **Dry Screen Process Inc.**, 1016 Madison Ave., Pittsburgh, Pa.

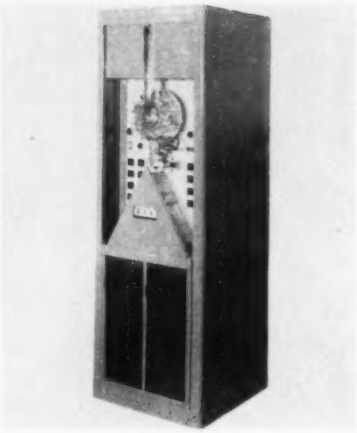
Circle 407 on Page 139

Power Controller

Item 408

Saturable reactors can control and regulate ac power from 1 kva to 3000 kva, single phase or 3 phase, at any voltage. Unit is suitable for use in metal melting, glass melting, and chemical processes. The power can be automatically controlled, regulated and varied by a thermostat or other external instrument or device. The saturable reactors can be connected directly to the distribution line or other supply, and can vary the output voltage from approximately 93 per cent to 10 per cent of that of the supply. When the voltage is reduced to the minimum, only about 1 per cent of the power is being used for control. **Sorgel Electric Co.**, 838 W. National Ave., Milwaukee, Wis.

Circle 408 on Page 139



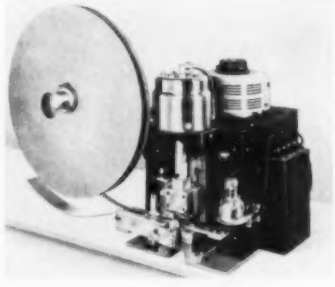
Diode Classifier

Item 409

Machine is capable of sorting up to 3000 diodes per hour into as many as 16 classifications. Model 276 can be used with existing test equipment and accommodates a four parameter *Forward-Back* resistance test sequence without rehandling. Diodes with bent leads are rejected prior to test.

In operation, the diodes are transported automatically from hopper to bins, and bin contents are displayed on counters. The handling machine requires only refilling of hopper and removal of filled bins. The equipment can be modified to handle axial lead components such as resistors and capacitors. Unit operates on 115v ac. **Electronic Control Systems, Div., Stromberg-Carlson, Div., General Dynamics Corp.**, 2231 S. Barrington Ave., Los Angeles 64, Calif.

Circle 409 on Page 139



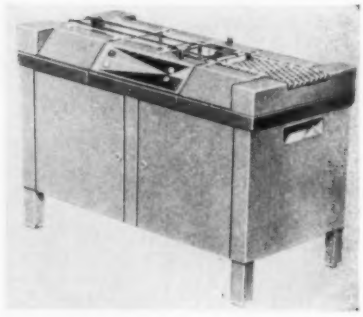
Terminal Assembler

Item 410

Automatic unit crimps, welds, and cuts off terminals and connectors in strip form supplied on disposable reels. Welding method covers stranded wires with a sheathing of the base metal, but leaves the weld visible. The sheath is plasticized before imbedding itself in the stranded wires. The terminal or connector is kept cool throughout the operation to prevent destruction of insulation on wires.

The welding machine is air actuated and the operation takes place in a single stroke of the ram. Required heat is preset on a rheostat. Unit can be mounted on a bench or stand. It is rated for 110-220v ac; 80 to 100 psi air. **Electric Terminal Corp.**, Warwick Industrial Park, Providence 5, R. I.

Circle 410 on Page 139



Package Weigher

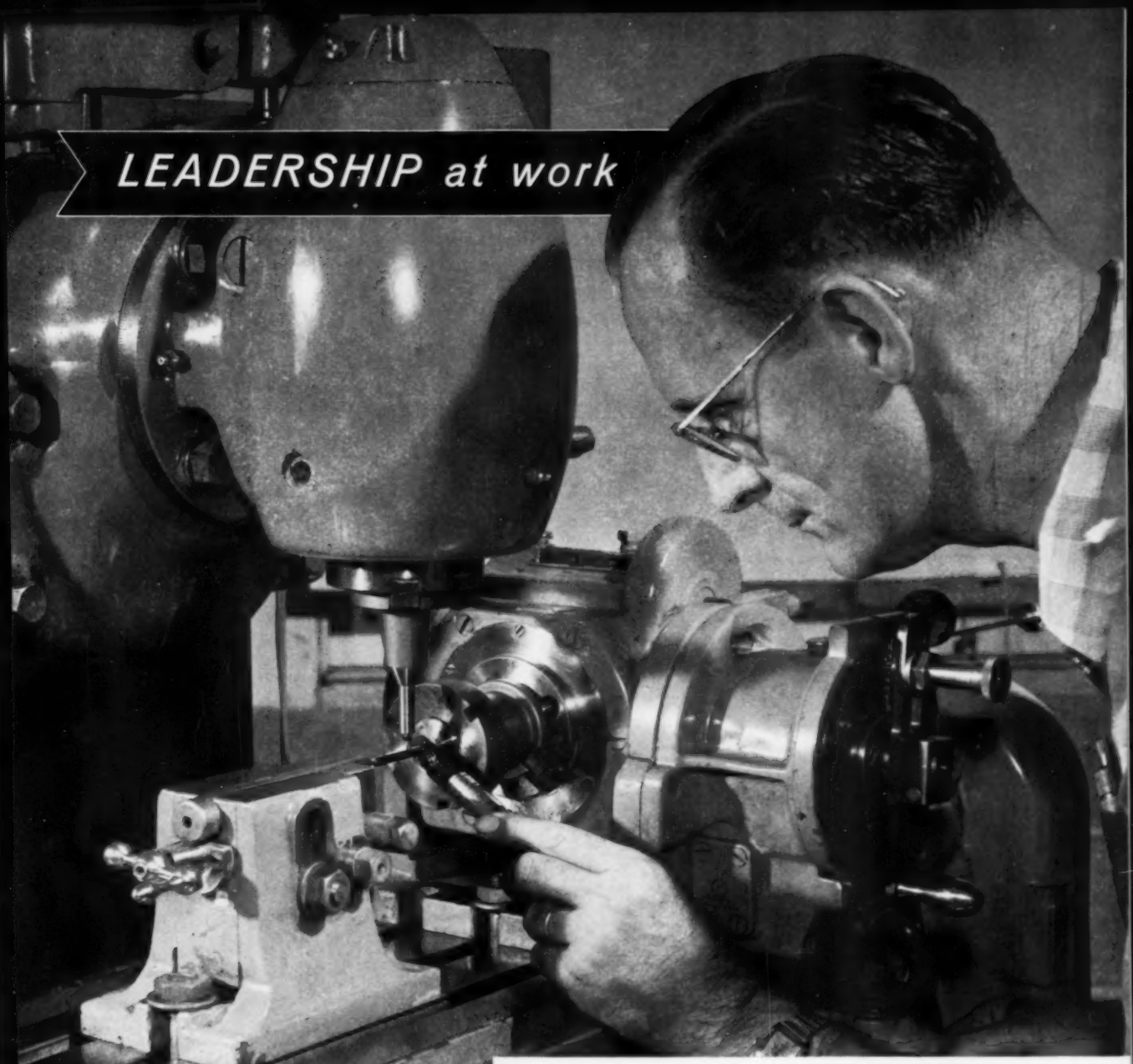
Item 411

Unit is designed to sense weight variations within ±1 per cent, at a rate of 400 units per minute. The machine can handle a variety of package shapes; round, conical, rectangular, or irregular. The height of the unit is adjustable from 30 to 42 inches to fit into existing conveyor systems.

Several routing variations are offered in segregating packages. Acceptable packages may be passed straight through with over and under weights diverted to the left and right; both over and under weights may be discharged to the same side; or correct and overweights may be passed with under weights discharged to the side or dropped down through the unit. Recording instruments or numerical counters can also be furnished. Weigher operates on 110 v, single phase, 60 cycles, has a built-in voltage regulator to insure accuracy. **FMC Packaging Machinery Div., Food Machinery & Chemical Corp.**, 4992 Summerdale Ave., Philadelphia 24, Pa.

Circle 411 on Page 139

LEADERSHIP at work



Target: tolerances fine enough to check gun-barrel rifling — Producing a spiralled air plug gage to check accuracy to .0002" calls for top performance from man and machine. Taft-Peirce Mfg. Co., Woonsocket, R.I., get both—from Fernand LeClair and a Kearney & Trecker—Milwaukee No. 2 Model CE universal milling machine. Picture shows spiral-milling of 440 stainless steel tubing, using a .050" end mill.

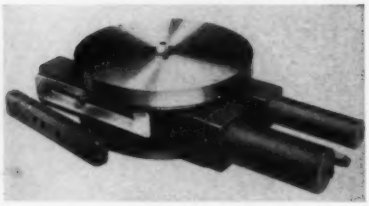
KEARNEY & TRECKER MILWAUKEE

6784 W. NATIONAL AVE., MILWAUKEE 14, WIS.

Kearney & Trecker's man on the job . . .
Henry Stewart of Stedfast & Roulston, Boston—helped Taft-Peirce select their precision mill. *For expert milling counsel, call the K&T man near you. And remember to ask him, or write direct, for free comprehensive catalog.*

Kearney & Trecker staff photo by Ron Johnson

Circle 680 on Page 139



Indexing Table

Item 412

Table has an indexing speed up to 100 times a minute, can be changed over for different indexes per revolution without changing plates. Accuracy is ±2 minutes. Air pressure is between 70 and 80 lb. Model shown has a 16 inch platform, offers 60 different indexing angles. Table is designed with toothed clutches to insure angular accuracy. Platforms up to 30 inches in diameter can be fitted to the table. **Wharton Unitools**, Valley Stream, L. I., N. Y.

Circle 412 on Page 139

Gain the economies of

AUTOMATION!

NEW chain-driven FEDERAL dial feeds

Federal Chain-driven Dial Feeds eliminate the need for specialized and more costly machinery. With automatic feeds and ejectors, these rugged presses step up production three to six times. Special jigs make their application virtually unlimited. Rotating table is driven by automotive, timing gear-type chain and provides 50% greater working area for the operator. Index and work plates operate on thrust bearings. Shot pin with tapered bushing assures absolute accuracy at each index. Rugged. Precision built. Eight sizes. Six to eighty ton capacities. See your dealer or write today.

Model 3—
26-ton capacity

FEDERAL PRESS COMPANY, 802 Division St., Elkhart, Indiana

FEDERAL DIAL FEED PRESSES

33 Years' Experience in Dial Feed Engineering and Construction

Gas Analyzer

Item 413

Model F is designed to provide centralized instrumentation for process control by continuous or intermittent sampling and measurement of combustible gases and vapors in mixtures with air at normal or high temperatures. Three basic systems can be provided by arrangements of five subassemblies. The systems provide continuous tube sampling of up to six individual stations; continuous remote head sampling of as many as six individual stations; or intermittent tube sampling of a maximum of eight stations.

Monitor units are used in all systems, one for each sample station. Each monitor has an indicating meter calibrated in per cent of lower explosive limit, a voltmeter, dc power supply, signal lights, receptacle for optional plug-in warning unit, terminals for recording potentiometer, and pushbuttons for alarm cutout and reset. Heads in the remote control unit have special detector cells and a high-temperature air-purge solenoid valve. Measurement is made in the hazardous area and transmitted electrically to the indicating or recording instrument. The station selector unit scans sampling stations automatically in timed sequence. Sample time per station is 30 seconds. The pump assembly unit which develops a vacuum of 2 inches of mercury, at a sample flow rate of 2 cfm, serves up to six continuously sampled stations or eight intermittently sampled stations. **Mine Safety Appliances Co.**, 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle 413 on Page 139

Save 27% or more in cost...

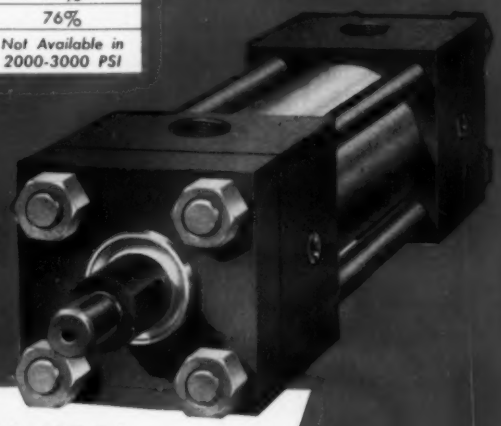
NEW

"JOB RATED"

HYDRAULIC CYLINDER LINE

JOB RATED, MODEL " J "			
BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

with ***IDENTICAL*** *seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.*



SEAL FAILURE MEANS CYLINDER FAILURE!

1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage because Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

TEFLON SHEF SEAL At Tubing Ends

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON Seals On Piston Rod And Bushing

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON Seals On Ball Check And Adjusting Screw

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

MILLER Uses Resin-Impregnated Leather Piston Cup Seals because they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

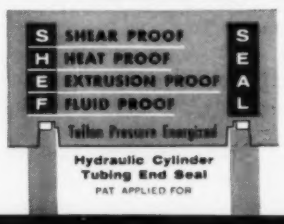
2. *Nicked or scored piston rods cause seal failure*

MILLER Uses Case-Hardened Chrome-Plated Piston Rods because they prevent nicks, scoring and rust.

Write for new bulletin giving complete details plus valuable data on column strength, cylinder forces, pipe sizes, safety factors, acceleration, air-oil devices, and other useful information.

NOW! . . . You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

We have assurance for tetrafluoroethylene resin which withstands temperatures from −100° F. to +500° F. and all hydraulic fluids.



OTHER MILLER QUALITY FEATURES

- Rust-Resistant Surfaces
- Interchangeable, Space-Saving Square, 4-Tie-Rod Design
- Precision Honed Barrels

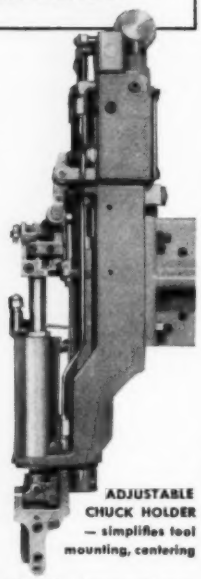
Circle 682 on Page 139

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION

2015 N. Hawthorne Ave., Melrose Park, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

SAVE TIME
AUTOMATING
SMALL PARTS
ASSEMBLY
OPERATIONS
SPECIFY
DIXON
"Auto-Positioner"



FITS IN SMALL SPACE—21" X 3¼" X 5" DEEP

ADJUSTABLE CHUCK HOLDER — simplifies tool mounting, centering

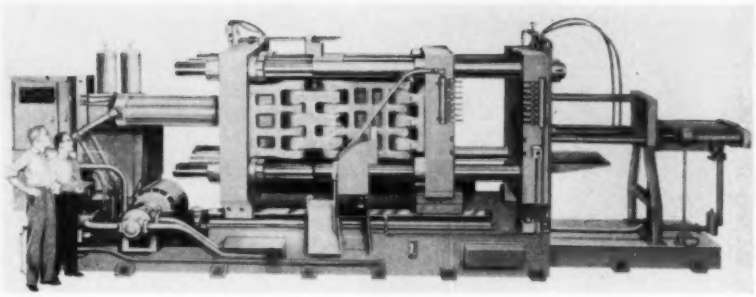
- STANDARD HEAD DESIGN—Saves engineering time. Easy to apply to variety of jobs. Operates on ordinary 80# air pressure, 110 volts. Has machined T-slot surface, simple adjustments. Tooling, mounting column, feeders, etc., optional.
- BUILT-IN SENSING—Acts as automatic inspector, assures quality production. Machine stops if part is missing or malformed.
- FAST, VERSATILE—Handles wide range of feedable metal or plastic parts from ⅛" to 3" O.D. at speeds up to 100 cycles per minute. Easy to tool.
- PRECISION-BUILT—Sturdy frame, one-piece super-finished piston and rod, cushioned air cylinder, J.I.C. controls.
- WRITE FOR FULL DATA—New circular gives complete specifications, shows typical applications.

DIXON PARTS ESCAPEMENTS
Releases single parts or in multiples at speeds up to 200 per minute. Standard models available for air, solenoid, or mechanical operation.

DIXON AUTOMATIC TOOL, Inc.
2312–23 rd AVENUE
ROCKFORD, ILLINOIS

Equipment for Automatic Parts Handling and Assembly

Circle 683 on Page 139



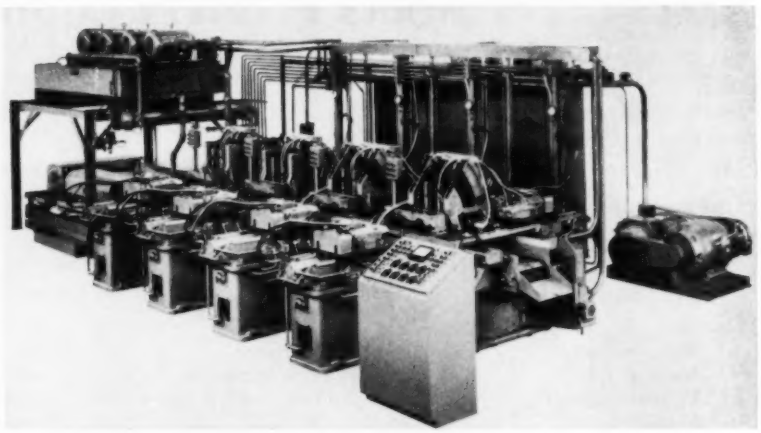
Aluminum Diecasting Machine

Item 414

Equipment is capable of producing large aluminum diecastings weighing up to 25 lb. The plunger can be adjusted to attain any speed up to 480 fpm. At any predetermined plunger position, the intensifier can generate plunger pressures up to 26,000 psi. A heat exchanger is provided to control the temperature of the hydraulic fluid. The movable platen is mounted on an adjustable roll support which prevents the weight of the platen and the die from resting on the horizontal tie bars. The rear platen is supported on rolls and high pressure swivel joints are provided on the die locking end of the machine allowing easy adjustment of the machine for different die heights.

Machine also features automatic lubrication, manifold hydraulic design, 230 gal. hydraulic reservoir, and an automatic timing remote control panel. This machine can be adapted for casting zinc. **Cleveland Automatic Machine Co.**, 4932 Beech St., Cincinnati 12, Ohio.

Circle 414 on Page 139



Automatic Gun Drilling Machine

Item 415

Unit is capable of drilling 0.296 inch diameter holes 16½ inches long on the axis of an automatic transmission output shaft, at the rate of 360 pieces per hour. Four stations in line are joined together. Each station carries a hydraulic slide with precision spindles driving gun drills. Spindle speeds are infinitely variable from 3000 rpm minimum to 9000 rpm maximum.

In operation, the parts are automatically loaded from a stacker to a hydraulic clamping fixture where the part is drilled. The finished part is automatically ejected and removed from the machine by a conveyor system. Chips are removed by a conveyor in the center of the base. Cutting oil is supplied by means of a high pressure rotary union at the rear end of the rotating spindle, through the spindle shaft into the tube of the gun drilling tool. Oil is cleaned by means of a filtration system and arrives at the cutting tool point at maximum pressure of

IT'S NO TRICK TO GET A "SPECIAL" TRUCK FROM THOMAS

This Thomas Balance Truck has a Q3 superstructure originally designed for safe handling of packages, paper and boxes. The three-sided steel panel design can be "Job-Suited" in various heights and pushbar arrangements.

They're "Job-Suited" to Products and Equipment!

Thomas builds hundreds of trucks to carry loads up to 50 tons and to work with all the latest powered equipment. Any one of these trucks can be "Job-Suited" with standard superstructures designed and built to hold your particular loads. An out-of-the-ordinary superstructure may speed up loading and unloading, carry your loads safely—save time, manpower and materials . . . actually save many times its cost.

For extremely unusual or difficult handling, the Thomas engineering department can design and build special equipment to meet your specific requirements.

Endless variations for shelf trucks.

Combination dolly and live skid for lift truck use.

All types and capacities of casters and wheels.

"Power-Suited" all-duty trailers, 1,000 to 10,000 lbs.

Replaceable flush top skid platforms.

Platform for use with both Jack and lift trucks.

Economical multiple-storage stacking boxes

Safety one-man drum truck

Adapted for overhead and underfloor towing.

Puts parts at machine height.

Elevated three-sided panel truck.

Rack truck for parts or tote pans.

A Thomas Representative . . .

is ready to help solve your handling problems. Write for your free catalog describing the complete line of Thomas "Job-Suited" Trailers, Trucks, Casters, Wheels and "Jak-Tung" Systems.

Only THOMAS Makes "Job-Suited" Trucks

THOMAS TRUCK & CASTER CO.
840 Mississippi River
Keokuk, Iowa

Circle 684 on Page 139

1000 psi. The cutting tool is driven by a torque drive adapter and prevents drill breakage beyond normal cutting tool load. If the gun drill is too dull or improperly ground, creating an excessive amount of torque while cutting, the torque drive rotates, contacting a switch. This takes the cutting tool out of *Feed* and causes it to *Rapid Return* to the back position. It also stops the rotation of the spindle and cuts off the supply of oil. **Crescent Tool & Machine Co. Inc.**, 25125 W. Outer Dr., Melvindale, Mich.

Circle 415 on Page 139

Turning and Boring Unit

Item 416

Applicable in the machine tool industry, vertical boring, facing, and turning unit is designed to machine parts such as marine propellers and other large diameter pieces. Complete programming of turret indexing, cross and vertical slide feed and positioning, as well as taper bore generating is available as an optional item.

Machine has a swing capacity of 72 inches and pushbutton control

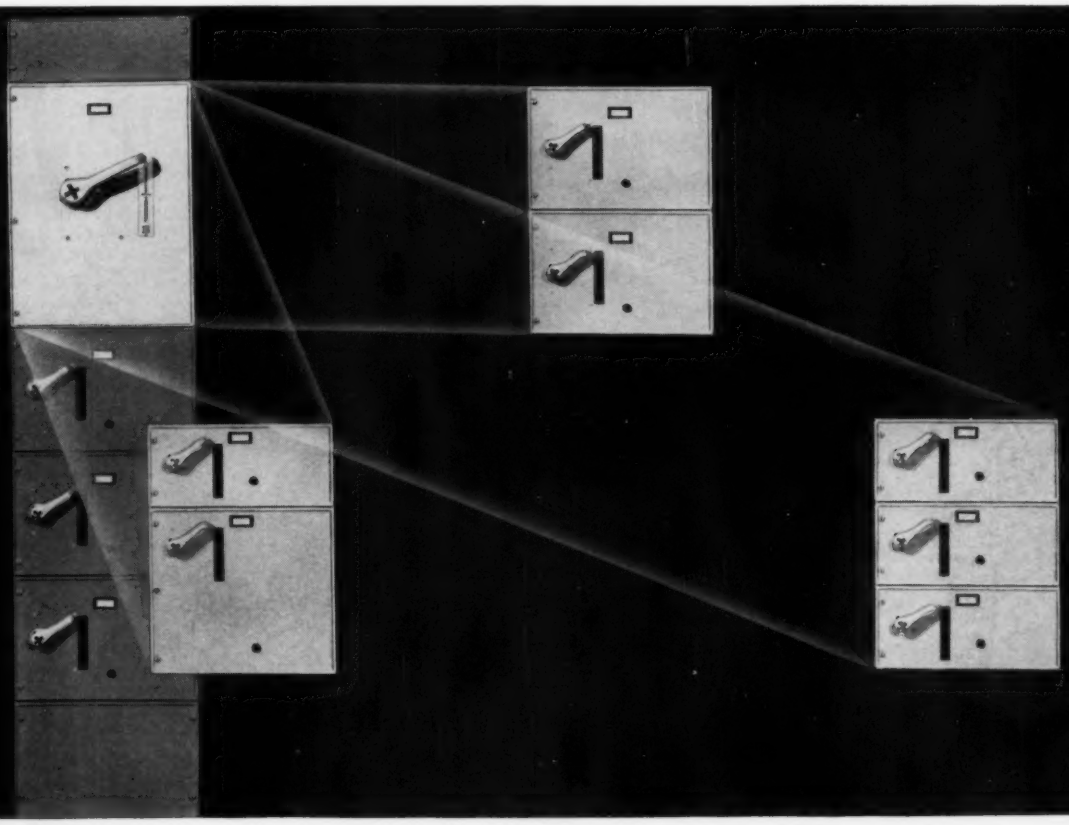
of all major machine functions. Infinitely variable spindle speeds ranging from 10 to 230 rpm are obtained by a control potentiometer for a motor generator set. Horizontal and vertical feed and rapid traverse movements are controlled by means of electric clutches. Taper boring is provided by two methods. With the first method, the vertical slide is inclined to the desired angle. Angle settings up to 20 degrees are available. In the second method, a taper bore generating attachment is mounted on the end of the cross rail. This attachment, which is controlled by electric clutches, couples the horizontal actuating screw and the vertical actuating spline in a fixed ratio. A selector switch on the control station engages or disengages this attachment. To accommodate various height workpieces, three separate mounting positions for the nonelevating rail are provided. **Frauenthal Div., Kaydon Engineering Corp.**, Muskegon, Mich.

Circle 416 on Page 139

Rotary Indexer

Item 417

Automatic rotary indexing unit is suitable for operations such as



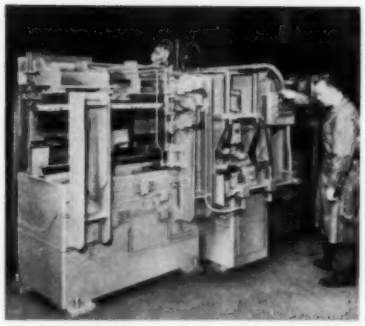
heavy drilling, milling, boring, and inspection. The machine can start at full load and the positioner can accommodate loads up to 50,000 lb. The worm is meshed with the wheel by axially sliding the worm until the backlash of the mesh is absorbed. If backlash develops, it can be eliminated by an axial adjustment of the worm. A change gear system permits varying the number of index positions per revolution. Any number of divisions can be set, from 10 to 2500. For controlled operation which permits the positioner to be used with a card or tape system, a tape attachment is available. Machine is available with horizontal or vertical tables in diameters up to 84 inches. **Lapointe Machine Tool Co.**, Hudson, Mass.

Circle 417 on Page 139

Horizontal Broacher

Item 418

Designed for automated engine lines, horizontal broaching unit is capable of machining cylinder-block bearing surfaces at a rate of 180 parts per hour. The bearing-joint faces of these blocks are held within 0.002-inch variation. The entire broaching cycle is automatic. Parts to be broached are conveyor fed into the loading station located at the left side of the machine. Work moves through the station from left to right, in an opposite direction to the cutting stroke of the broach. From the load station, two hydraulically operated transfer bars move the cylinder block onto the hydraulic trunnion fixture at the center of the machine. The fixture swings up, positioning and hydraulically clamping the part for the broaching pass. Then the fixture swings down and another part is fed into position for broaching and at the same time the completed part moves into the unloading station at the right for transfer to a conveyor. Hydraulic power for the unit is furnished by a system using a vane-type pump. The ram has a two-way adjustment, moves on precision hardened and ground ways. **Colonial Broach & Machine Co.**, P.O. Box 37, Harper Station, Detroit 13, Mich.



Circle 418 on Page 139

Case Stacker

Item 419

Unit is applicable in all food and beverage processing and conveying

Westinghouse CONTROL CENTERS feature dual-modular units to solve your space problems

The efficient design of these new Westinghouse units is the answer to today's . . . and tomorrow's . . . need for complete flexibility in control center installations. Westinghouse control centers are ready to meet any demand for expansion or modification.

You get complete versatility with dual-modular units, plus unit space selection to meet your demands. Steel or aluminum Westinghouse control centers will house a complete range of devices to meet specialized control requirements.

For complete information on the control center for your plant, call your local Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

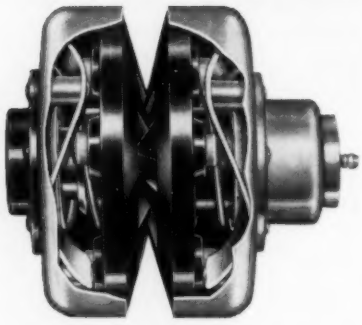
J-22107

POWER-UP starts with CONTROL

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 685 on Page 139

Hi-Lo Load-O-Matic Control Eliminates Pulley Slow Down



Hi-Lo Variable Speed Pulleys positively maintain the desired speed ratio over a wide range of load variation by means of an exclusive cam and cam follower assembly. This means:

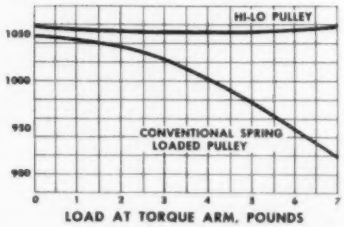
Pulley speed is independent of load and load changes. "Drag" is eliminated and high shock absorbency provided.

Pulleys do not compress belt due to spring pressure. Springs are not driving members. They act only to keep pulley faces in contact with belt.

Pulleys automatically regulate belt tension. Because of the cam assembly, belt is never under more tension than required by the load.

Double cams maintain constant belt alignment.

HI-LO PULLEYS COMPARED TO OTHER VARIABLE SPEED PULLEYS



PLUS THESE OTHER FEATURES:

- Smaller in size than comparable units.
- Quickly and easily installed.
- Replaceable face assemblies drastically cut repair and replacement costs.
- Available in sizes from .5 to 5 hp., ratios to 2.5/1 (single pulley) 6.25/1 (double pulley).

Request details and prices. Ask for Bulletin A-458.

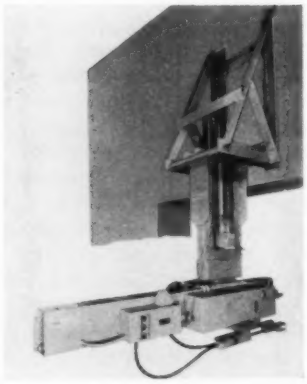
Manufactured By HI-LO MANUFACTURING COMPANY

Nationally Distributed By LOVEJOY FLEXIBLE COUPLING COMPANY 315 N. Lavergne Ave. Chicago 44, Ill.

Circle 686 on Page 139

systems. Mechanical in operation, machine stacks all wooden, metal, or wire cases from 3 to 7-high, or allows the cases to pass through the machine singly. It is adjustable to all case sizes. Unit is supported on four adjustable ball feet, is ready for operation after plugging it into a 220 v, 3 phase ac electrical outlet. It uses a ¾ hp motor. Removable steel panels allow for easy maintenance. **Lathrop-Paulson Co.**, 2459 W. 48th St., Chicago 32, Ill.

Circle 419 on Page 139

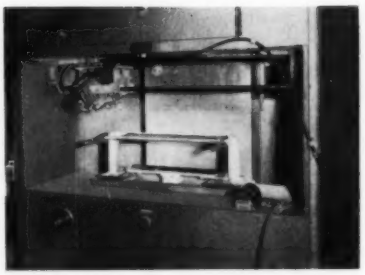


Overhead Arm Unloader

Item 420

Unit consists of an overhead arm with a built-in vertical slide adjustment, an air-powered straight line press unloader and a mechanical jaw assembly. It is capable of unloading stampings from presses in a straight line. Vertical adjustment of the unloader can be made at floor level through a self-contained, hydraulic-powered lift mechanism in the overhead arm. The arm bolts to mounting pads on the crowns of presses. The unloader can be raised vertically by a distance sufficient to clear the press working area for die setting operations, or it can be swung in a horizontal plane to a position parallel to the press frame. The latter action avoids crane chain interference during die setting. Various straight line press unloader and jaw assemblies can be mounted on the unit to meet a wide range of press unloading requirements. **Press Automation Systems Inc.**, 25418 Ryan Rd., Centerline, Mich.

Circle 420 on Page 139



Spray Painting Machine

Item 421

Device is designed to spray paint large parts, has an adjustable gun stroke to permit spraying of smaller pieces. The guns spray downwardly in the direction of the exhaust, so that painting both the outside edges and ends of shaped objects is facilitated. The part is held firmly in its mask by a pressure pad actuated by an air cylinder. Reciprocating action of the spray guns is by chain drive, powered by a hydraulic unit. Model 4800 is designed so that it cannot start spraying in the middle of a part, and the number of strokes is adjustable. **Finish Engineering Co. Inc.**, 1115 Cherry St., Erie, Pa.

Circle 421 on Page 139

Data Processor

Item 422

Suitable in the integrated data processing field, instrument is capable of automatically selecting and sorting data which is encoded in punched tape, without first converting it to punched cards. The tape skips through a reader until a preselected code is read. A row of seven selection keys on the front panel of the unit offers a choice of up to 127 different address codes.

When used with company's Flexowriter and solenoid-operated

adding machine, it becomes a tabulator and can automatically sort totals and subtotals of quantity, price, or other numeric factors, as a by-product of listing selected item classifications. Readout on the Flexowriter is in excess of 100 words per minute.

A repeat search operation allows the machine to perform data processing directly from by-products of the original punched tape. Compound searching is possible by insertion of a stop code in the tape to initiate a second search for subclassification items. Identical master tapes containing all the variables covering a large variety of products can be used at two remote locations. **Friden Inc.**, 2350 Washington Ave., San Leandro, Calif.

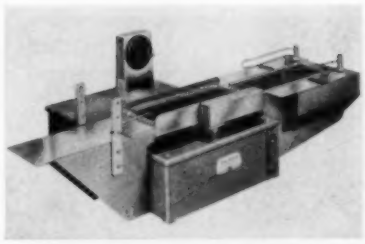
Circle 422 on Page 139

Forming Drop Hammer

Item 423

Applicable to operations such as forming, embossing, and coining, forming drop hammer can accept parts from automatic feeding devices. Precise blow control is provided by maintaining close pressure tolerances on the air supply and by the adjustment of a regulating valve on the hammer's exhaust air system. Electrical control arrangement permits synchronization of feeding devices. The machine will not operate if there is no material in place. A wide range of blow intensities can be made with a few adjustments. A safety rest supports the ram while making die changes and adjustments. **Chambersburg Engineering Co.**, Chambersburg, Pa.

Circle 423 on Page 139



Automatic Checkweigher

Item 424

Electromechanical unit is used for checking the weights of packages or similar items moving on a conveyor. Model 9455 can handle items weighing up to 32 ounces with an accuracy of ±1/16 ounce. The conveyor portion of the machine consists of a weigh section with motorized conveyor, and an *Approach* and *Take-away* section. To signal an unsatisfactory item, both visual and audible alarms are available. For rejected items, a motorized *Take-away* and a diverting gate mechanism, which sends the items into a reject container, are available. This mechanism can con-

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2811 W. FORT ST. DETROIT 16, MICH.

Circle 687 on Page 139

MOLINE
HD68 drills bolt circles from 12" to 100" diameter. Each of the two spindles has capacity for 2½" drill in steel. Operating cycle is fully automatic.
HD13 straight line-type drilling machine with capacity for thirty ¾" drills in steel. Used for work on heavy castings, round and rectangular steel tubes, structural shapes, plates and grader blade drilling or countersinking.
For Greater
PRODUCTION . . . EFFICIENCY . . . SAVINGS
Use an individually designed "Hole-Hog" Machine Tool for such jobs as...
Multi-Spindle Boring
Single and Multi-Spindle Honing
Straight Line Multi-Drilling
Adjustable Spindle Drilling
Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
Transfer-Type and Special Machines
OVER 57 YEARS OF MACHINE TOOL ENGINEERING EXPERIENCE IS AT YOUR SERVICE. TELL US YOUR PARTICULAR PROBLEM
13CB hydraulic feed cylinder boring machine. V-8 engine blocks are rough and finish bored for wet-type cylinder sleeves. Units of this kind are applicable for transfer machines.
MR152 performs drilling, reaming, spot facing and chamfering operations on tractor rear axle housings. A companion machine, MR151, does tapping in addition to the foregoing operations. Work holding fixtures are mounted on power driven trunnion.
MOLINE TOOL CO. HOLE-HOG MOLINE, ILLINOIS
MOLINE TOOL COMPANY
REPRESENTATIVES IN PRINCIPAL CITIES
100 20TH STREET • MOLINE, ILLINOIS
109

sist of a single gate to divert all rejected units in one direction, or a double gate to send underweight items in one direction and overweight items in the opposite direction. **Toledo Scale Div., Toledo Scale Corp.,** Toledo 13, Ohio.

Circle 424 on Page 139

Numerical Positioner

Item 425

Suitable for small-lot production jobs, numerical positioning control unit is applicable for any operation requiring point-to-point positioning of linear or rotary motions. Unit consists of operator's control, position pickup devices, and a tape reader. The control provides for individual or simultaneous linear and rotary positioning and has an electrical accuracy of ±0.0005 inch at travel lengths up to 99.99 inches. For length of travel up to 399.99 inches, electrical accuracies of ±0.005 inch can be obtained. Positioning speeds up to 60 ipm can be reached. Machine can operate automatically from numerical data stored in standard eight-channel, 1-inch wide punched tape, or manually by decade switches. **General Electric Co.,** Schenectady 5, N. Y.

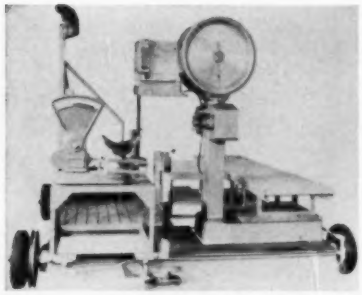
Circle 425 on Page 139

Portable Batch Weigher

Item 426

Motor - driven tramcar has two scale dials, can formualte an entire batch and automatically record the individual weights of compounds and ingredients. Ingredient weights are printed on a continuous tape; the total batch weight is also recorded

Circle 688 on Page 139



when the batch is emptied into the mixer, providing a second check for errors. Tramcar is electrically propelled through power received from an overhead pulley operating on a trolley wire. Channel guides dictate the direction, acting as rails for the rubber tired wheels.

In operation, a roller conveyor receives tote boxes which are tared by means of sliding poises in the back of the dial scale column. With the dial scale at zero, the operator moves the tramcar past the storage bins or delivery spouts and withdraws compounds and ingredients. When the dial shows the right amount, the flow of material is cut off and the weight of the material is printed on a continuous tape. A small fan type dial scale is used for weighing out small amounts of ingredients such as accelerators and retarders. **Richardson Scale Co.**, Van Houten Avenue, Clifton, N. J.

Circle 426 on Page 139

Bulk Storage System

Item 427

Unit is designed to store all free flowing dry granular materials. System includes storage tanks and conveying equipment such as augers, buckets, elevators, belt conveyors, and pneumatic filling units. Of all

completely redesigned

REEVES *Vari-Speed MOTOR PULLEY*

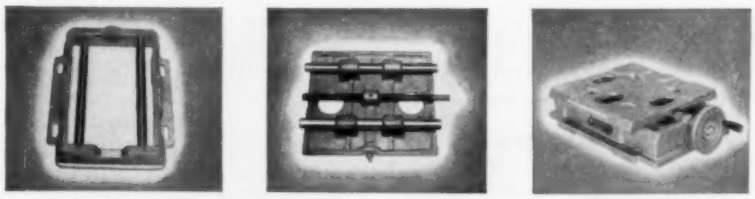
Here is variable speed control in its most simplified form . . . ; variable speed control with new economy.

Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ¼ hp. through 15 hp., to fit both old and new NEMA motors.

Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin AN36A-V582.

Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.



Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

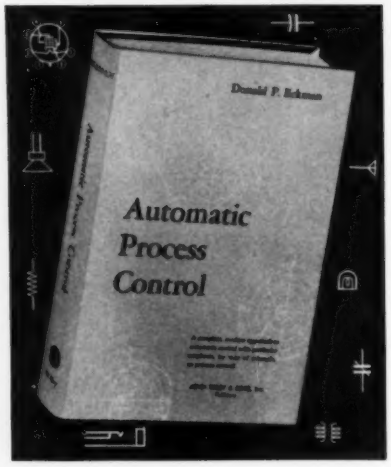
REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 689 on Page 139

A complete,
up-to-date approach . . .



Automatic Process Control

By DONALD P. ECKMAN,
Case Institute of Technology

If you are concerned with instrumentation, this book gives you just the analytical, mathematical and theoretical background you need. It presents the important principles of automatic control, emphasizing block diagrams and frequency techniques in process control. Beginning with process analysis, it goes on to discuss the generalized behavior of closed-loop systems. System problems are given a great deal of study.

Note this special coverage:

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- Controller Characteristics
- Closed Loop in Automatic Control
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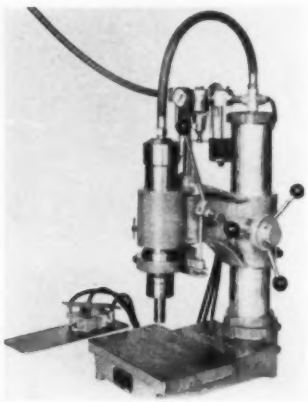
Circle 690 on Page 139

steel construction, the tank has no corners, is available in sizes from 2.1 to 34.8-ton capacities with a 60 degree center discharge suspended hopper for free flowing materials or a side discharge hopper for products that have a tendency to clog. Loading and unloading of the material may be handled by accessory belt and screw conveyors and vertical bucket elevators. Special tanks can be designed to meet specific requirements. **Butler Mfg. Co.**, 7400 E. 13th St., Kansas City 26, Mo.

Circle 427 on Page 139



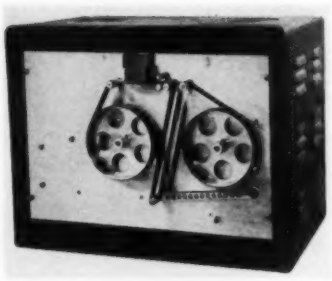
Repeating Air Hammer

Item 428

Model 300-RH is adaptable to operations such as riveting, staking, crimping, coining, and sheet metal working. The cylinder and head frame assembly can be used as components of automatic machines and mounted at any angle. The tool is keyed against rotation and is a precision fit with the collet.

In operation, an auxiliary air traverse mechanism controlled by a foot valve lowers the hammer cylinder to bring the impact tool down onto the work and hold it there during the work cycle. Valving is internal and is actuated by contact pressure. If the contact pressure is maintained the hammer will repeat from 1000 to 2500 times per minute, depending on the air pressure used. When the foot pedal is released, the hammer cylinder is lifted away from the work. **Heidrich-Nourse Co.**, 631 E. Third St., Los Angeles 13, Calif.

Circle 428 on Page 139

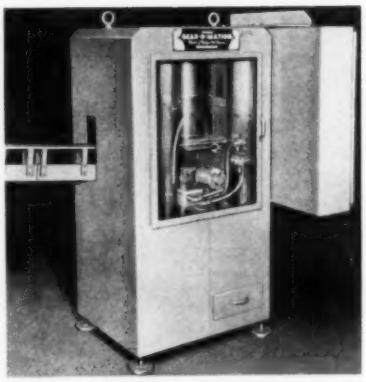


Data Storage Unit

Item 429

Device can store up to 10 million bits, has an average access time of less than ½ second. Model 3270 consists of a tape transport mechanism with transistorized drive and programming circuits. Each of the two reels on the transport contains approximately 35 feet of one-inch wide tape which, starting from the center of the tape, can be scanned by the head in either direction in less than ½ second. Direction of tape travel is determined by input programming; at end-of-tape, a preprogrammed 50 millisecond stop is inserted, and the tape travel is reversed. When storage of more than 10 million bits is required, individual transport units can be added and mounted in a single rack. **Potter Instrument Co. Inc.**, Sunnyside Boulevard, Plainview, L. I., N. Y.

Circle 429 on Page 139



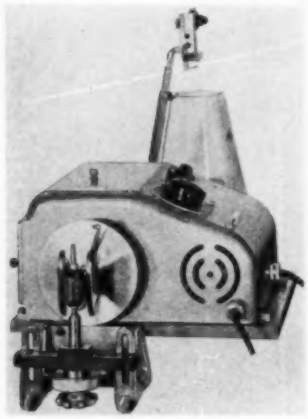
Castings Cleaner

Item 430

Unit can be assembled from standard components, is suitable for the air cleaning, orienting, and elevating of machined castings such as pump housings. In operation, the parts enter the unit through a gravity track to a *Stop*

position at the first station where they are cleaned by air jets working off shop lines. After cleaning, the parts continue along the track to the second station where they are rotated for proper orientation (by automatically inserting a pin into the oil port on one irregularly contoured flange of the part) before entering the elevating shuttle. The parts are then elevated to the height of the exit chute and slide down a gravity track, properly oriented, to the next operation. A glass front door provides visual inspection. **Gear - O - Mation Div., Michigan Tool Co.**, 7173 E. McNichols Rd., Detroit 12, Mich.

Circle 430 on Page 139



Armature Winder

Item 431

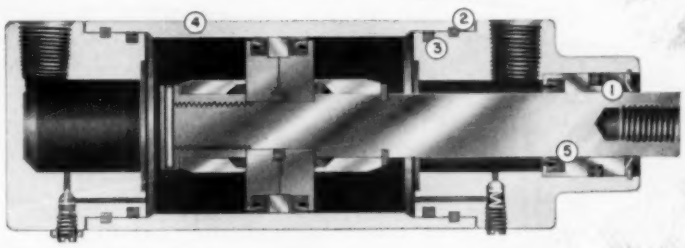
Unit features a self resetting automatic counter which requires no handling or resetting until the turns count is changed. Model 46-MCA winds straight or skewed armatures for regular production runs and external stator windings which are reversed for each alternate pole. The machine is capable of handling stacks from 1 inch to 2½ inches in diameter and up to 2½ inches long, using 20 to 40 gage wire. The stationary vertical position of the armature provides a safety measure in that the armature cannot fly out and cause injury to the operator. Winding speed is up to 3000 rpm. Unit is furnished with a tensioner, a complete set of gears, an automatic stop, an automatic brake release and ¼ hp 5000 rpm motor. **Geo. Stevens Mfg. Co. Inc.**, Pulaski Rd. @ Peterson, Chicago 30, Ill.

Circle 431 on Page 139

CARTER

CYLINDERS

AIR OR HYDRAULIC



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ROTARY ACTUATORS • SPECIAL CONTROLS

Circle 691 on Page 139

200 Operations At 85 Stations

There are 21 operations performed at the 8 stations, in the Rotary Section; and, 179 operations at the 77 stations, in the In-Line Section, of this new, 120 foot, Walking Beam, Transfer Type automatic giant. *One casting is machined, completely, every 38 seconds.*

Same Machine Handles 3 Models

It was designed to machine, completely, 3 different types of compressor housing castings—(1) for an automotive air conditioning unit; and, (2) and (3) for different models of air conditioning units, for commercial and industrial use.

All Operations Fully Automatic

Every probe and size checking station, automatically checks the parts in process. Interlock switches also operate the signal lights on the console, to indicate the functioning of each station. If a gage rejects a part, the machine stops, automatically, and the console indicates the rejection point.

Handles One Model At A Time

Many of the operations, on this machine, are common to all 3 castings, while others are selective, and performed on only certain castings. In changing from one model to another, the tools, not required for the model to be machined, are simply indexed to proper position, removed from their respective spindles, or electrically cycled out.

Hydraulically Operated Clamps

Hydraulic Clamps automatically engage the castings, at each work station, to secure them for the machining operations. In many stations, hydraulic jacks supplement the clamps, to support the castings against the thrust of the cutting tools.

Walking Beam Transfers Parts

The bellcranks are rocked by hydraulic cylinders, to elevate and lower the transfer beam, without changing their position lengthwise. The cross head is reciprocated by a lever, which is powered through a rack and pinion, by a hydraulic fluid motor.

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MACHINE TOOLS COME FROM

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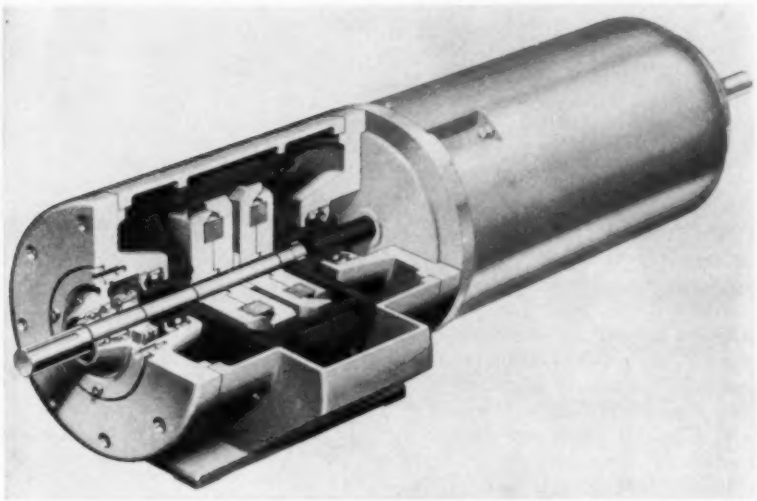


Variable Speed Eddy Current Drive

A variable-speed drive, designated the MARVEX, has been developed by **Cone-Drive Gears, Div., Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit 12, Mich. The device can be driven by a constant-speed motor to drive a load at infinitely variable speeds up to 95 per cent of motor speed. It is an electromagnetic eddy-current unit with controlled slip and no mechanical connections. It is applicable on pumps, compressors, extrusion machines, punch presses, rolling mills, conveyors, and machines requiring rapid and frequent reversal. The drive is available in four models: An eddy current coupling, a coupling and integral motor, a coupling and integral motor and right angle gear reducer, and a coupling and integral motor with special output shaft. Each model is offered in six sizes ranging from 30 to 450 lb-ft torque capacities.

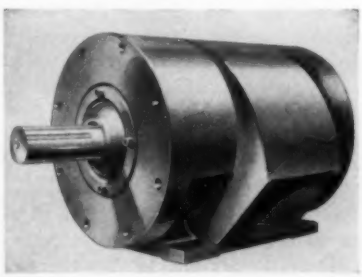
Torque transmitting capacity of an eddy current variable speed drive is a function of its slip and its excitation. No torque can be transmitted unless there is a small amount of slip in the drive. The unit is designed to transmit its rated torque with a minimum slip of about 5 per cent. Twice this torque is available from the drive for starting the load if the driving motor can develop twice its rated torque. The motor can also be started with no load and the load applied as quickly or as slowly as needed.

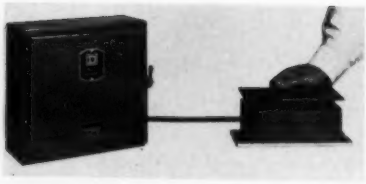
Since the device is a torque transmitting drive, it cannot substitute for a gear or belt transmission. If the input shaft of the eddy current drive is running at the speed of the driving motor, any desired output shaft speed up to 95 per cent of motor speed can be obtained by controlling the eddy current excitation.

The excitation unit consists of an ac-dc rectifier fed from the regular ac line. The supply unit varies with the characteristics and functions required from the eddy current drive. In some cases, characteristics similar to those of a dc shunt-wound motor are required. The amount of dc current fed to the eddy current drive is automatically controlled by means of a speed-responsive device actuated by the output member. Such a device feeds back a signal which is used to increase or decrease the dc voltage applied to the drive's excitation coils. The desired speed of output shaft rotation is selected by a manually operated knob.

In other cases, characteristics similar to those of a dc series wound motor may be provided with an adjustable rectifier. Additional or alternative characteristics for the drive can be furnished by numerous variations and combinations of the two basic systems. Functions such as inching, creeping, torque-limiting, and controlled accelerating can be incorporated.

Circle 432 on Page 139





Air-Gap Limit Switch

Item 433

Switch operates on the principle of a resonant circuit, is applicable on operations where heavy impact and shock are frequent. Unit consists of three parts; a magnetic vane which is attached to the moving portion of the machine; a reactor unit mounted on the stationary portion of the machine; and an ac relay which opens or closes the circuit.

In operation, the action of the magnetic vane passing over the reactor actuates the relay. High sensitivity permits the switch to function when the vane is within 7/8-inch of the reactor. Operation is not affected by voltage variation up to ±10 per cent. The switch can operate in the same temperatures as a mechanical limit switch, as there are no vacuum tubes. **Electric Controller & Mfg. Co., Div., Square D Co.,** 4500 Lee Rd., Cleveland 28, Ohio.

Circle 433 on Page 139

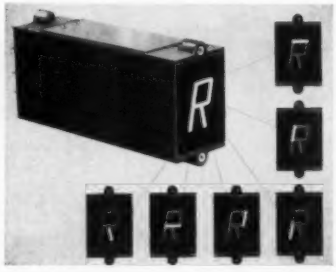
Surface Thermocouple

Item 434

Unit is designed for accurately measuring and closely controlling the surface temperature of rotating rolls, shafts, and bearings. The temperature reading is unaffected by changes in roll velocity, and constant bearing pressure of the thermocouple is assured by an internal spring. The unit features a fast response for close control, and there is no heat loss due to windage.

Sensing element in the thermocouple is a brass plug which is flush mounted in a spring loaded Teflon plunger. This Teflon body bears against the roller, forming a protective shield from surrounding air. Thermocouple is furnished complete with bracket and head. **Conax Corp.,** 2300 Walden Ave., Buffalo 25, N. Y.

Circle 434 on Page 139

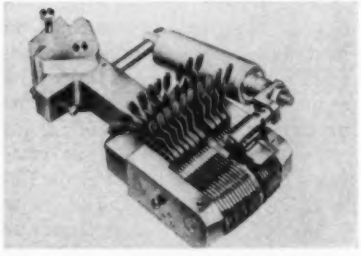


Alpha-Numeric Display

Item 435

Unit which will display any letter A through Z, or any number 0 through 9, is designed for use with electronic data handling and processing systems. All characters or numbers appear on the front surface of the display unit. Device uses a 12-bar matrix, each bar having a miniature projection lamp behind it. By projecting each bar through its own lens system onto a single plane screen, and by the selection of the proper combination of any of the 12 bars, any desired letter, number, or symbol can be formed. Display is offered in single units for assembly in groups of 2, 3, 4, etc., for panel mounting. **Industrial Electronic Engineers,** 3973 Lankershim Blvd., North Hollywood, Calif.

Circle 435 on Page 139



Numbering Head

Item 436

Model 484 is designed for roll marking a 20-digit number in a curved line into flat work pieces with a permanent impression. The head is used in a general purpose roll marking machine. The unit automatically indexes after each roll marking stroke to give consecutive serial numbering. This function is performed by a 1 1/8-inch bore air cylinder operated directly from the marking machine cycle. Unit has a barrel-shaped wheel assembly for roll marking on flat surfaces. The head pivots on the dovetail shank pivot pin during the roll marking stroke. The engraving on each wheel is off center so that the roll marked impression is on a curve or radius. **Noble & Westbrook Mfg. Co.,** Westbrook St., East Hartford 8, Conn.

Circle 436 on Page 139

Temperature Alarm

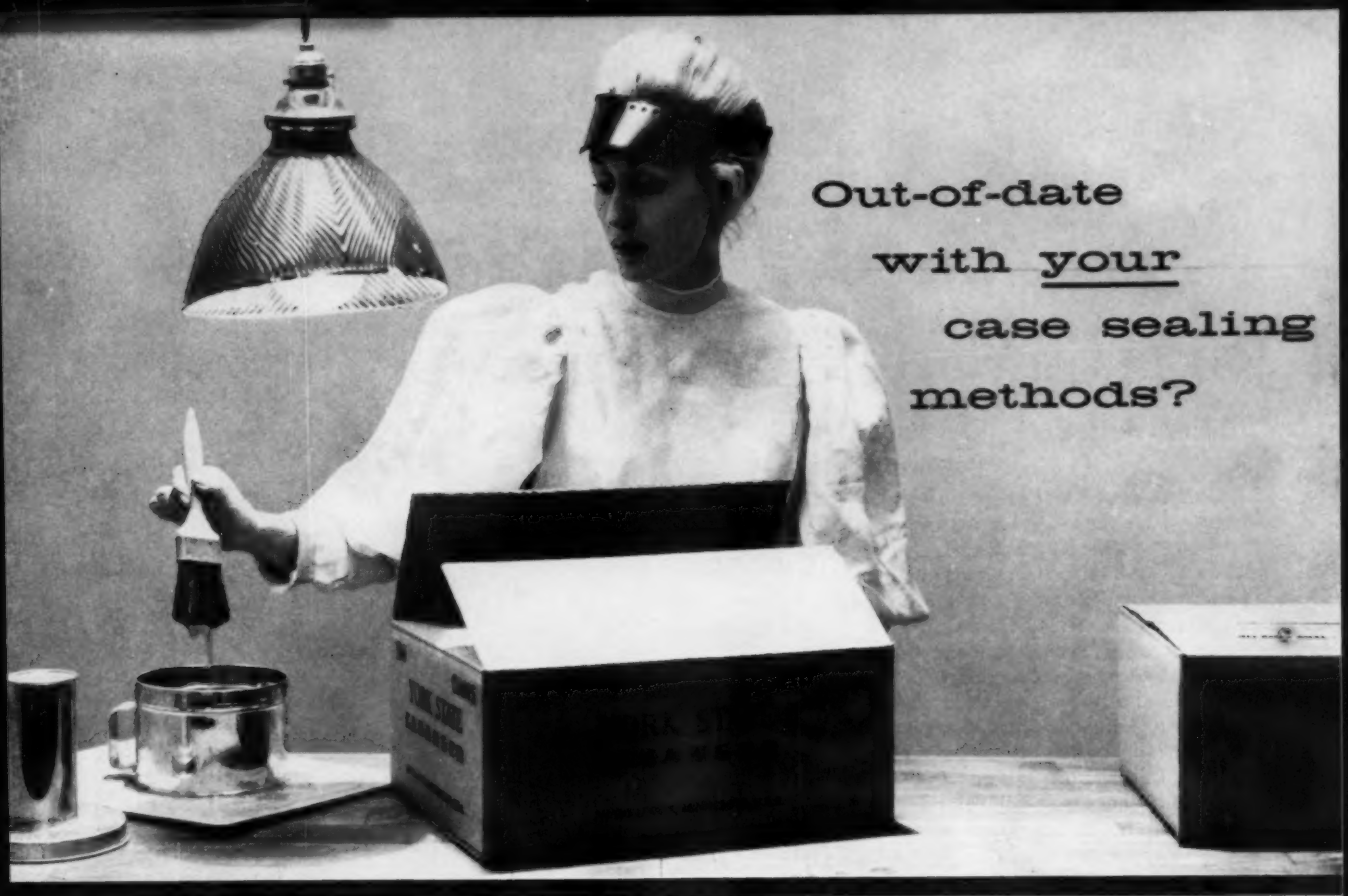
Item 437

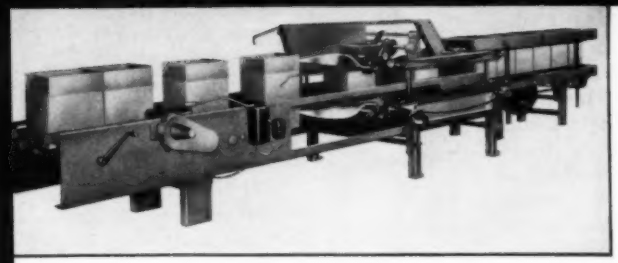
Device is applicable on operating processes where temperature is critical. Model 124, an electronic temperature alarm features four-way protection. If the temperature is within the proper range, a green signal lights. If the temperature is below range, a red signal lights and a warning buzzer sounds. If the temperature is above range, two red signals light and a warning buzzer sounds. If the current fails, another warning sounds. The sensitivity is ±0.3 F.

To operate, the alarm is plugged into a 110 v ac receptacle, the mercury thermostat is plugged into the temperature control unit, and the switch turned *On*. Unit is protected from overload by a fuse. Current for the second warning buzzer comes from two flashlight cells. Temperature settings are ordered for specific applications. **Philadelphia Scientific Glass Co.,** Paletown Rd., Box 46C, Quakertown, Pa.

Circle 437 on Page 139

Circle 693 on Page 139→





PACKOMATIC FULLY-AUTOMATIC CASE SEALER

Loaded shipping containers IN, sealed cases OUT—and no operator needed! It aligns corrugated cases, positions flaps, glues, seals and discharges fully-automatically. Packomatic was first with this production-proved machine. It's available in a wide range of case sizes for installation on your present line. Semi-automatic, too.

J. L. FERGUSON CO. Joliet 2, Ill.

New York, Chicago, Cleveland, Boston, Tampa, Baltimore, Portland, Denver, Los Angeles, San Francisco, Seattle, New Orleans, Louisville, Kansas City and All Principal Canadian Cities.

PACKOMATIC machines include the Bale Sealer — Case Sealers — Opener-Loaders — Case Imprinters — Telescoping Volumetric Filler — Packer-Gluers. Units available, semi-automatic or fully-automatic depending on your needs.

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equipment feeds, forms, positions, loads, seals, and imprints shipping containers automatically

Fully-automatic Packomatic Custom-Engineered machines go all the way—or any part of the way—with your packaging operations. Modernize your present line with a fully-automatic case sealer—or really put it into high gear with a Packomatic that feeds, forms, and positions shipping containers, end-loads them with cans or cartons at top speed, then discharges them sealed and imprinted, ready for shipment. Most important, only one part-time operator is needed for the whole operation. Labor costs are obviously reduced. End-loading techniques shrink paper board costs up to 28% and your whole output takes a sharp climb. Packomatics can save time and money. Let us show you.

PREMIER SHOWING: Packomatic's newest high-speed bulk-packaging machine. PM&ME Booth 709

Six 5-qt. cans or gallon cans in 20⅛" x 13⅝" x 9 13/16" case and 20¼" x 13¾" x 8¼"

Twelve 46 oz. cans in 21" x 13" x 7⅛" case

Twenty-four cartons in 12½" x 10⅝" x 8½" case

Eighteen 7 & 8 oz. cartons in 20" x 14⅞" x 8⅛" case

Sixty cigarette cartons King Size: 17⅛" x 11½" x 22" Regular: 14 1/16" x 11½" x 22"

TYPICAL CASE LOADING PATTERNS FOR CANS AND CARTONS

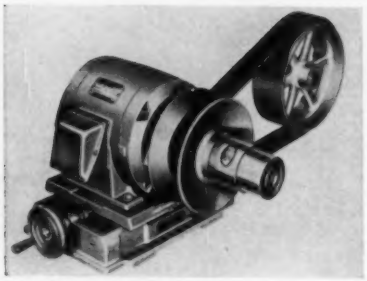
Twenty-four 12 oz. cans in 14⅜" x 10 15/16" x 5 5/16" case

Six No. 10 cans in 22 1/16" x 17⅜" x 7⅛" case

Thirty 1 lb. cartons in 16⅛" x 10 9/16" x 7¼" case

Twenty-four cartons in 19½" x 10⅛" x 7" case

Forty-eight cartons in 22¾" x 23½" x 15⅛" case



Motor Pulley

Item 438

Unit is designed for applications from ½ through 15 hp, with up to 4 to 1 ratios of speed variation. The disc assemblies have three main parts; two smooth-face, cone-shaped discs and a spring. One disc is mounted in a fixed position on the motor shaft, the other slides laterally on the hub of the fixed disc. The spring automatically maintains correct belt tension at all output speeds. Lubrication system is designed to maintain a film of lubricant between the hub length of the fixed and the bore of the sliding disc. One lubrication point services the entire disc assembly. Separately mounted countershaft assemblies are available to step-up or step-down speeds to the driven machine. **Reeves Pulley Div., Reliance Electric & Engineering Co.**, 1225 Seventh St., Columbus, Ind.

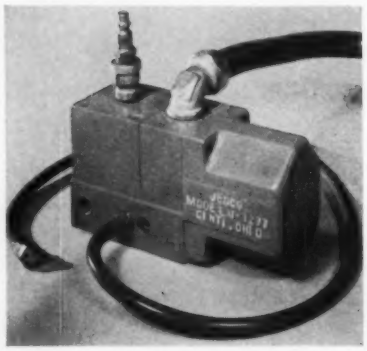
Circle 438 on Page 139

Solenoid Valve

Item 439

Line of valves is designed to permit full flow of air, water, oil, and other media. Valve is a 2-way, normally closed, pilot-operated unit with a synthetic insert for bubble-tight operation. Valve can be mounted directly to a line, and operate in any position through pressures ranging from 5 to 150 psi and temperatures from −40 F to 180 F. A long life is provided by the small area of the diaphragm that is exposed to pressure. Also available are valves for normally open operation, with options such as manual override, explosion-proof construction, and a choice of electrical connections. **Skinner Electric Valve Div.**, Dept. L157, 105 Edgewood Ave., New Britain, Conn.

Circle 439 on Page 139



Proximity Transducer

Item 440

Unit is applicable for bank control in parts feeders, or for monitoring automatic assembly operations within the 0.016-inch maximum range of the device. The self-contained pneumatic proximity transducer is capable of providing an electrical signal from the presence of a part near the pick-up nozzle. The power input is factory air at 70 to 100 psi and the output is fed to an integral pneumatic pressure switch which can handle an electrical signal of 110-230 v ac at 15 amps or 110 v dc at 5 amps.

Transducer is available in five models, each one arranged to provide a signal at a specific distance between the part and the pickup nozzle; 0.001, 0.002, 0.004, 0.008, and 0.016 inch. The pickup nozzle can be connected in parallel to permit one unit to indicate the condition at several related locations before a signal is given. Accuracy is within ±10 per cent. The presence of light, fragile, or nonmagnetic parts can be read, as there is no mechanical contact between the pickup and the workpiece. **Jessup Engineering & Development Co.**, 4289 Glendale-Milford Rd., Cincinnati 42, Ohio.

Circle 440 on Page 139

Dry-Type Power Center

Item 441

Compact unit features either top or bottom entrance. Power center is available in 5 and 2.5 kv classes for high voltage, and 600, 480, 240, and 120 v on the low side. Three-phase power ratings are from 45 to 300 kva. An air-insulated three-phase loadbreak switch (with or without fuses) is used. The 45 kv switch has a NEMA Class A rating of 600 amp load current for 500 operations, or Class B rating of 600 amp for 100 operations. Unit is designed with a vibration-absorbing mounting. The low-voltage panelboard is in a separate section of the transformer compartment. Barriers prevent raising of ambient temperature in the breaker compartment by heated air from transformer. **Westinghouse Electric Corp.**, Box 2099, Pittsburgh 30, Pa.

Circle 441 on Page 139

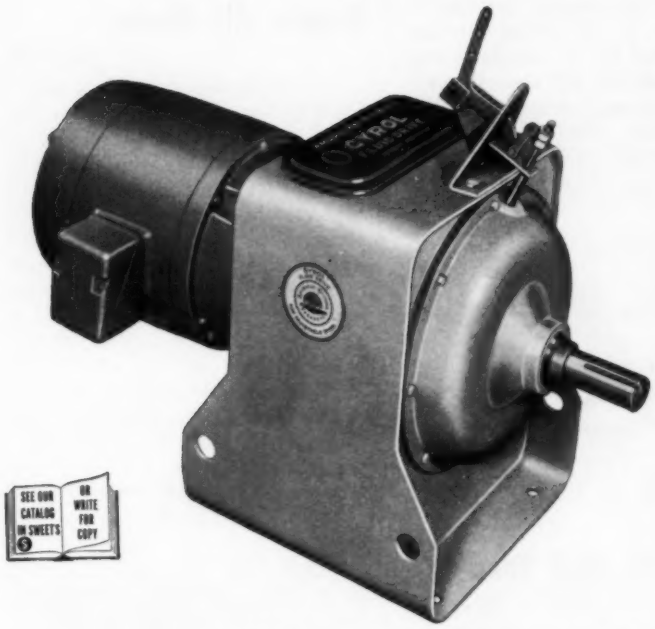
Crane Hook Switch

Item 442

Switch is designed to prevent hoist and crane overloading. When overloading occurs, the switch automatically cuts off all power to the motor; the operator presses the reverse switch, which returns the load to the floor. The surplus weight is removed before the pickup can be completed. Unit can be set in the field to operate at any point between 500 and 10,000 lb. It is available with one or two adjustable

Get full value from adjustable-speed drive:

American Blower *Gýrol*® Fluid Drive varies speed steplessly without costly maintenance



Feature for feature, American Blower Gýrol Fluid Drive is your most economical solution to many industrial-drive problems. Here's why:

- **Stepless speed control**—simple, wear-free speed controller; manual or automatic operation.
- **Shock protection**—vortex of oil isolates shock; protects costly machines.
- **Controlled acceleration**—permits no-load starting—gradual application of power to accelerate the load.
- **Full reversibility**—fast, easy; just change motor rotation even when running; provides dynamic braking.

Compact and self-contained, Type VS, Class 2 Gýrol Fluid Drives come in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. Get full information today from one of our 73 branch offices! Or write: American-Standard*, American Blower Division, Detroit 32, Mich. In Canada: Canadian Sirocco products, Windsor, Ont.

COMPARE . . . THEN SPECIFY GÝROL® FLUID DRIVE!

Feature	Shock Protection	Maintenance Record	Accuracy	Service Limit	Horsepower Rating
GÝROL FLUID DRIVE Type VS, Class 2	Vortex of oil isolates shock.	Good—few wearing parts; extra-long service life.	Simple, wear-free speed control.	Unlimited—all Gýrol Fluid Drive ratings are for continuous service.	Units available up to 800 hp.
FRICTION-TYPE DRIVE	Mechanical connection transmits shock.	Poor—multiple wearing parts; power transmitted by friction.	Wear and tension affect control.	Limited—service factors influence selections.	Units available up to 100 hp.

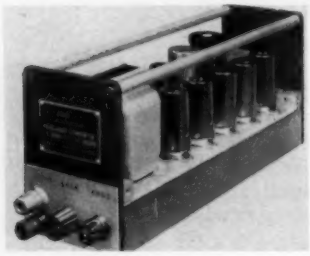
* American-Standard and Standard ● are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

Circle 694 on Page 139

limit switches to control mechanical forces at various load points. The switch can also be used to ring bells or operate warning lights. **W. C. Dillon & Co. Inc.**, 14620 Keswick St., Van Nuys, Calif.

Circle 442 on Page 139



Frequency Converter

Item 443

Applicable in telemetering, computer, and other electronic data handling systems, converter has 0.1 per cent linearity. Silicon zener diodes are used to assure stability. Transient response is 1 millisecond. Range of the converter is 100 to 5000 cps with other ranges available. Output is zero to 1 ma per 1000 cps of input continuously variable, with a built-in span adjustment. **Cox Instruments Div., George L. Nankervis Co.**, 15300 Fullerton Ave., Detroit 27, Mich.

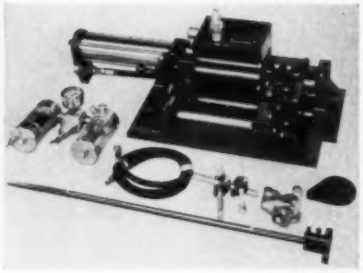
Circle 443 on Page 139

Tool Monitor

Item 444

Suitable for use on any machine tool operation, device is designed to monitor tool wear and machine operating conditions. It gives a visual indication if there is an increase or decrease in power consumption. The dial located on the outside allows the operator to calibrate the instrument to 100 per cent load for the desired amperage by setting the indicator knob to that amperage or to the desired point that will indicate tool wear limit. By cancelling out the portion of the load that is not important, such as the non-cutting load, the unit gives a constant visual reading of the amount of wear taking place while the tool is in operation. Automatic compensation for line voltage changes and voltage transients insure that the reading received is that caused by the actual machine load and not by an outside source. Unit is rated for 110 v ac, is available in amperage ranges up to 300. **Futurmill Inc.**, 6360 Highland Rd., Pontiac, Mich.

Circle 444 on Page 139



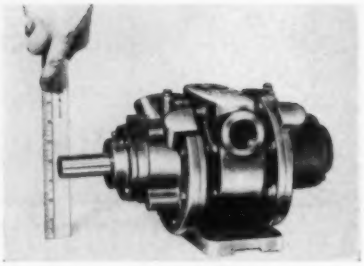
Pneumatic Coil Feed

Item 445

Designed for automatic operation of mechanical and hydraulic stamping presses, air operated slide feed can also be used as a feed to power shears, power brakes, four slide machines and welders. Unit has a pulling power of 250 lb, can grip the stroke with a force of over half a ton without marking the material. It operates on air pressures of 60 to 100 psi.

Feed can be mounted on either side, front or back of presses, and can be timed by the press ram or crankshaft. It can also be arranged to operate the press. Features include fast feed length changes, hydraulic cushions for shock-free operation, and a quick release lever for fast stock changing and setting. Unit is available in 6, 12, 18, and 24 inch feed length sizes. Rated capacities for mild steel are $\frac{1}{8}$ inch thick for 6-inch width, 1/16 inch for 12-inch width, and 1/32 inch for 18-inch width. **Cooper Weymouth Inc.**, 600 Honeyspot Rd., Stratford, Conn.

Circle 445 on Page 139



Rotary Air Motor

Item 446

Unit is explosion-proof, is adaptable for use in explosive or inflammable atmospheres. Speed is infinitely variable from 300 rpm and up, with an air valve control. Operated by compressed air at pressures to 90 psi, the rating is 5.8 hp at 1500 rpm; 7 hp at 2000 rpm. Standard rotation is counterclockwise. Model 16AM is available as a foot or base unit. Four tapped holes are also provided on the end for flange mounting to a gear box or any other driven unit. **Gast Mfg. Corp.**, P. O. Box 117, Benton Harbor, Mich.

Circle 446 on Page 139

Printing Counter

Item 447

Five-digit printing counter makes up to 500 counts per minute, and prints the total instantly. Printing action is initiated by a pushbutton on the unit, or by remote control. The counter automatically resets to zero after each impression or gives cumulative totals. The unit can be wired so that the printing action is just the opening and closing of a contact, and if the action is an ac pulse, the rectifier in the unit will change it to dc. It operates on 110

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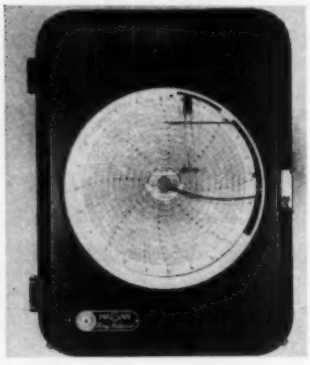
v, 60 cycle dc provided by a self-contained power supply. Optional equipment such as additional counters for simultaneous printing on the tape; equipment for printing the time and date to the nearest minute each time the count is printed; and the printing of code letters and numbers that are remotely selected; can be furnished. **Royson Engineering,** Hatboro, Pa.

Circle 447 on Page 139



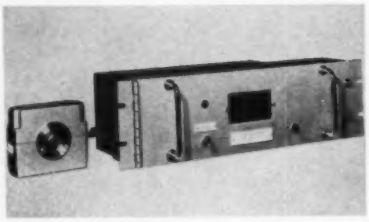
Electronic Recorder

Item 448

Unit can be used as an ac servo operated bridge or dc potentiometer recorder. It is designed to accept electrical signals for conversion into a shaft position suitable for operating recording, indicating, and integrating mechanisms. Instrument is capable of recording any quantity measured by a ring balance meter, including fluid density, liquid level in open or closed vessels, and temperature and pressure compensated fluid flow readings.

The electronic receiver of the recorder consists of a unit housing an amplifier, an input box, a servomotor, and a slide wire. As many as four receivers can be installed in a single recorder. The recorder is actuated from an input box containing components for the individual measurement. This supplies a drive signal to an ac amplifier which causes a reversible motor and feedback potentiometer to move to the precise output shaft position required to balance the circuit. The reversible motor also drives the recording pen arm linkage securing a pen position proportional to the input quantity. **Hagan Chemicals & Controls Inc.,** 323 Fourth Ave., Pittsburgh, Pa.

Circle 448 on Page 139

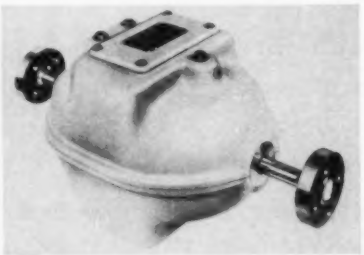


Position Indicator

Item 449

Applicable in machine tool position indicating, equipment is designed to provide a continuous indication of a shaft position on either a digital display for visual indication or on various recording media, or both. Recording can be done on a punch, typewriter, tape punch, or adding machine printer. Encoders and translating modules are used in the system. The encoders can read out at speeds up to 120 rpm and indicate continuously as the position changes. Models are available to indicate feet and inches to one millionth of an inch; degrees, minutes, and hundredths of minutes; hours, minutes, and seconds to hundredths of seconds. **G. M. Giannini & Co. Inc.,** 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 449 on Page 139



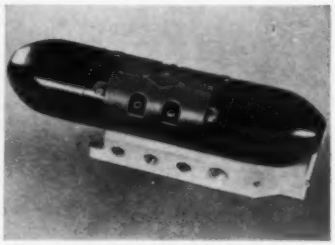
Magnetic Flow Meter

Item 450

Unit is available for ½-inch flow lines; is suitable in ratio flow control systems where small flows are in proportion to larger ones. Meter has an accuracy of 1 per cent of full scale throughout the entire scale, and its performance is said to be unaffected by pressure, viscosity, density or changes in conductivity of the flowing liquid.

Transmitter unit consists of a nonmagnetic flow tube containing metallic electrodes and an ac electromagnet. When a conductive liquid passes through the tube, an alternating voltage is set up between the electrodes which varies linearly in proportion to the volume rate of flow. Lead wires from the electrodes transmit this voltage output to a recorder, producing a chart record in appropriate units of flow. Flow rates as low as 3 gpm can be measured by the instrument. **Foxboro Co.,** Foxboro, Mass.

Circle 450 on Page 139



Control Valve

Item 451

Multipurpose directional control valve is available in single and double solenoid models, can be used for air, water, or oil. It can be operated to 1000 psi. The valve body and spool are treated to hardness and finished to a tolerance of 0.00005 inch. The assembly contains ½-inch passages and can be supplied with ¼, ⅜, or ½-inch pipe ports. The subbase mounting of the valve has permanently imbedded wiring and a junction box with conduit connection for easy wiring. **Alkon Products Corp.,** 200 Central Ave., Hawthorne, N. J.

Circle 451 on Page 139

Multiturn Limit Stop

Item 452

Miniature multiturn limit stop features low inertia, low starting friction, and easy adjustment; is suitable for high speed applications. A range-setting screw at the end cap adjusts the stop rotation from zero to full scale continuously and

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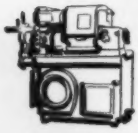
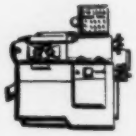
Centerless Grinders

Cold Headers



Automatic Screw Machines



Thread Rollers

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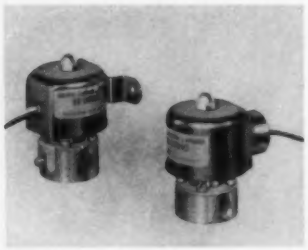
Manufacturers of Automotive Clutches and Machine Tools

precisely. Device is available in two models, zero to 10 revolutions and zero to 40 revolutions. The limit stop is 0.875 inch in diameter, synchro mounted, 15/32 inch long in the first model, and 1⅞ inches long in the second model. Torque capacity is 40 ounce-inches. **Precision Mechanisms Corp.**, 577 Newbridge Ave., East Meadow, N. Y.

Circle 452 on Page 139

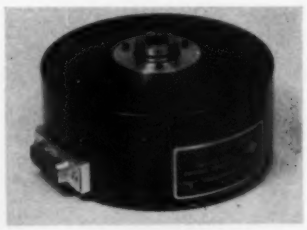


Solenoid Control Valve

Item 453

Applicable on automatic machinery, welding equipment, and spray equipment, solenoid valve can be used for air, gas, water, oil, and all industrial fluids. Model 291 is a compact 2-way normally closed unit designed for use in tight equipment corners and crevices. All internal working parts in contact with media are stainless steel. Valve is available in ⅛-inch or ¼-inch size. Maximum working pressure is 300 psig. **AP Controls**, 2450 N. 32nd St., Milwaukee 45, Wis.

Circle 453 on Page 139



Position Encoder

Item 454

Line of angular position encoders is suitable for converting positional analog data into digital form. The data are converted to numerical form directly. The alignment of shaft bearings is not a problem, and enables the encoder to be easily mounted. The encoder disc is mounted on a hollow shaft which

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CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

Circle 698 on Page 139

can be slipped on and coupled rigidly to the shaft of the instrument to be digitized. **Wang Laboratories Inc.**, 37 Hurley St., Cambridge 41, Mass.

Circle 454 on Page 139

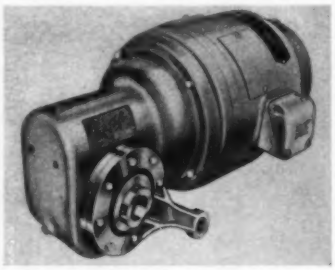
Function Generator

Item 455

Instrument is applicable in linear programming of nonlinear functions, programming environmental test conditions, and in process control operations. Model SF-1 includes a chart-supporting drum, a resistance roller, and two contact rollers. A synchronous motor or other actuator provides the driving force for the chart drum. Any single-valued function is drawn with a special conductive ink on the chart so that a raised conductive line represents the desired function. A reference voltage is impressed over the length of the resistance roller so that a given point along the length of that roller is at certain proportional voltage. Constant contact is maintained between the drawn function, the resistance roller and the contact rollers during operation of the generator. The operating principle is similar to a slide wire potentiometer with the point of contact between the curve and the resistance roller serving as the slider arm of the potentiometer. Electrical continuity between the resistance roller and contact rollers is established through the conductive function curve. Output voltage in the circuit through the resistance roller, the conductive curve, and the contact rollers is then proportional to the displacement of the curve from a reference line.

In process control operations, the electrical control applied to the load must be held constant. For this application, the chart drum is positioned bv a servo motor and amplifier. The chart drum carries a plot of volts vs amps for the required power. It is positioned according to the load current and establishes a voltage reference equal to that needed for constant power. This reference voltage is compared with the load voltage which is adjusted accordingly. **Alabama Automation Corp.**, P. O. Box 875, Huntsville, Ala.

Circle 455 on Page 139

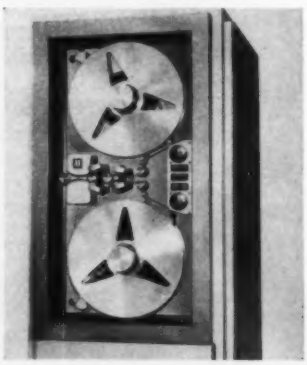


Hollow Shaft Reducer

Item 456

The hollow shaft design of the right-angle motor reducer permits direct coupling to equipment by inserting the drive shaft of a machine. Unit can be mounted in limited space and in various positions; side, overhead, vertical, shaft up or down. Reducer is available with standard single-speed motors, or as a unit combining magnetic brakes, slip ring, or 2-speed drive motors. Reducer is furnished with 13 gear reduction ratios from 18 rpm through 250 rpm; horsepower range is from ½ through 2. **Reuland Electric Co.**, Alhambra, Calif.

Circle 456 on Page 139



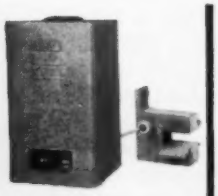
Tape Transport

Item 457

Unit is suitable for telemetry applications and other analog data

POST DECITRON ELECTRONIC PRODUCTS

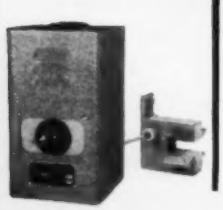
Controls & Timers



Model K-1

Model K-1
This is a general purpose photoelectric control whereby the interruption of a light beam closes a relay which, in turn, can be used to activate an external circuit.

Model K-2
The "K-2" control differs from the "K-1" in that the output relay will not energize for each interruption of the light beam, but only if interruptions cease. Useful for detecting stoppage "flow".



Model K-2

Model TA-1 — *Industrial Timer*
. . . a general purpose electronic timer which requires no warmup time and offers good repetitive accuracy. Actuation of the timer is by external contacts, momentary or sustained.

See "Post" at the Automation show, Booth #444, N. Y. Coliseum

Decitron

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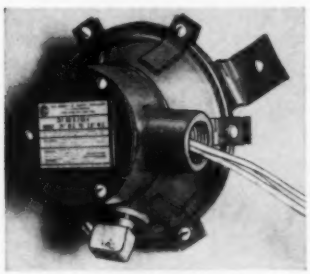
acquisition systems. The transport is equipped to handle up to 14 inch reels, and they can be changed in the field. Six tape speeds from 60 to 1⅞ ips are available instantaneously by selective switching. A search and control capstan operated at 120 ips permits selection of descriptive data at any point on the tape. Sensing arms automatically stop the tape before the end of the reel. Transport is mounted on a drawer type chassis, features easy removal of subassemblies. A two-speed version of the transport is also available. **Davies Laboratories Div., Minneapolis-Honeywell Regulator Co.**, 10721 Hanna St., Beltsville, Md.

Circle 457 on Page 139



Pressure Switch

Item 458

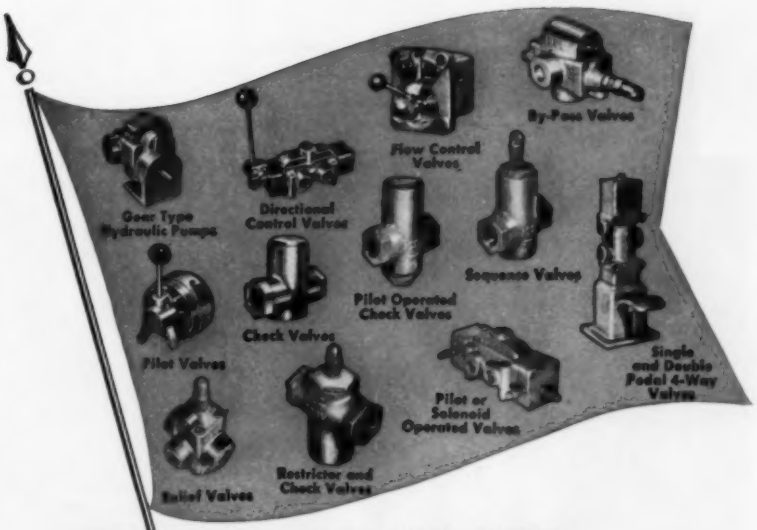
Control is suitable for gases or liquids when using pressure connections. It is designed to sense a single valve of pressure or vacuum of 0.05 inch to 40 inches water column. Fixed *On-Off* differentials are obtainable, depending on the diaphragm size. Control is available in 4-inch, 8-inch, and 10-inch diaphragm size. Unit is rated for 120-250 v ac, 15 amp, ⅛ hp, or 125 v amp pilot duty. **Henry G. Dietz Co.**, 12-16 Astoria Blvd., Long Island City 2, N. Y.

Circle 458 on Page 139

Threaded Insert

Item 459

Device is designed to provide a strong internal thread for bolt attachment in soft materials such as aluminum and magnesium alloys and plastics. It can also be installed in the harder metals to provide a self-locking internal thread in a blind hole. The inserts are externally threaded along the entire



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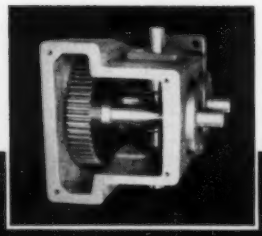
TEXAS
Air-Draulic Equipment Company
Houston, Texas

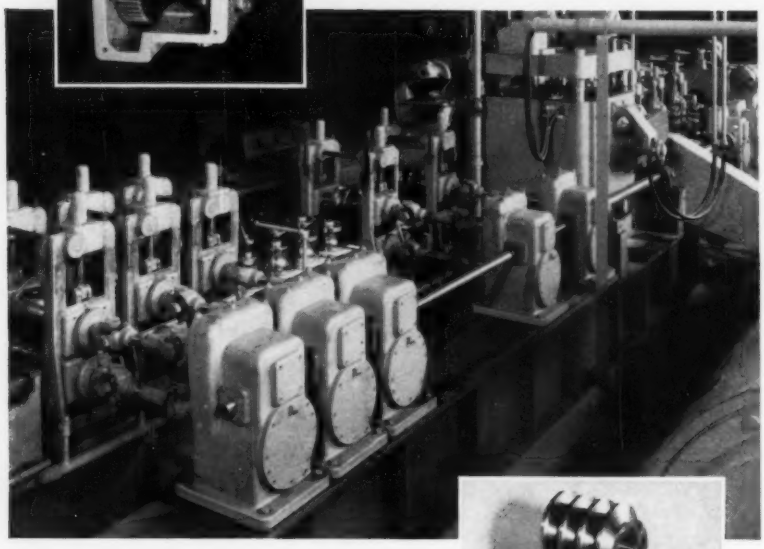
UTAH
Robert Taylor & Sons
Salt Lake City 10, Utah

WASHINGTON
Russ Chamberlin Company
Seattle, Washington

Circle 700 on Page 139



Open view of drive unit shown below on machine.



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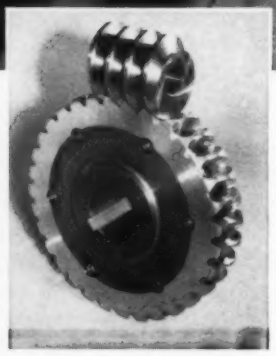

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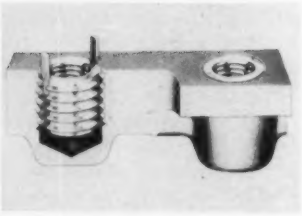
5112 Hamilton Avenue
Cleveland 14, Ohio



length for maximum pull-out resistance. Positive mechanical resistance to rotation is provided by the keys which are tightly fastened in the insert and are pressed into the base material with a small punch or hammer. The internal thread self-locking arrangement grips the bolt after approximately 1 bolt diameter of thread engagement. **Newton Insert Co.**, 6500 Avalon Blvd., Los Angeles 3, Calif.

Circle 459 on Page 139

Air-Operated Pump

Item 460

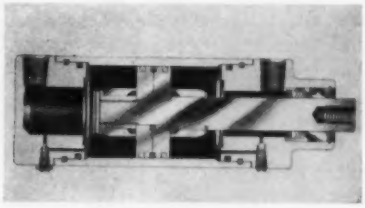
Designed for high-pressure testing or powering of equipment, air-operated hydraulic pump uses either oil or water as the fluid medium. The pump is capable of static and burst pressure testing of tubes, hose, valves, and cylinders; testing of flows which require relatively low flows at high pressures; and operating hydraulic presses and other hydraulic equipment in fixture clamping, pressing, metal forming, piercing, blanking, and staking.

In a circuit that provides automatic control, the pump will maintain the required pressure indefinitely. Whenever the pump is idle, the air piston actuating valve is automatically positioned on the power stroke, eliminating stalling. A filter-regulator-lube assembly in the air supply line and a suitable filter in the fluid supply line are all that is required to operate the pump. Unit is available in nine sizes, capable of producing from 500 psi to 25,000 hydraulic pressure from a maximum of 100 psi air

Circle 701 on Page 139

pressure. **SC Hydraulic Engineering Corp.**, 6318 Central Ave., Los Angeles 1, Calif.

Circle 460 on Page 139

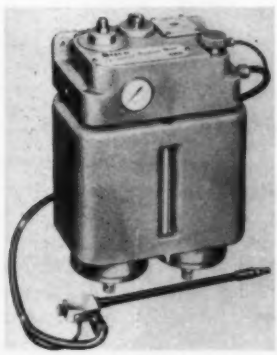


Heat Resistant Cylinder

Item 461

Device is applicable on heat treating, drying and annealing ovens, on brakes and clutches, and in high temperature process operations. A combination of high temperature packing and grease provides steady operation at temperatures as low as −20 F to temperatures as high as 500 F. At the rod end of the cylinder are heat resistant spring-loaded packings, and the rod is surrounded by lifetime silicone grease in grooves adjacent to the packing areas. Pressure service ratings for the air cylinder is to 150 psi, and for hydraulic, 350 psi. Bore sizes are from 1½ to 8 inches, with stroke lengths to 18 feet. **Carter Controls Inc.**, 2800 Bernice Rd., Lansing, Ill.

Circle 461 on Page 139



Mist Coolant System

Item 462

Applicable on dry operations, equipment is connected to a machine circuit by a solenoid valve, starts when the machine is turned on. Unit includes spray jet, air filter, trap, regulator and gage, solenoid valve and conduit box, pres-

RICHARDS-WILCOX R-W AURORA ILL.

NEWS OF THE LATEST DEVELOPMENTS IN OVERHEAD CONVEYING SYSTEMS

NEW DEVELOPMENTS MAKE R-W "TWIN-TRAK"* AN EVEN GREATER BOON TO PRODUCTION "PROFIT-IMPROVEMENT"

Today, more so than ever before, manufacturers realize the need for better materials handling methods . . . a need that will not diminish but increase due to higher material and labor costs. In fact, with these rising costs and a business slow-down on one side plus sharper competition on the other, manufacturers are recognizing the fact that they *must* modernize materials handling methods to stay in business.

The development of the unique R-W "TWIN-TRAK" Overhead Automatic Dispatch System offered manufacturers an entirely new concept of efficient and economical handling of materials. This system consisting of one or more power tracks and as many storage tracks as desired plus switches, carriers and power-equipment, not only moves products from one point to another, but automatically and economically conveys parts or products to predetermined work stations from "storage banks" installed in the free overhead areas under the building trusses . . . releases valuable floor space for production operations. The economy and value of the R-W "TWIN-TRAK" System was immediately recognized by the manufacturing industry and many firms now have R-W "TWIN-TRAK" Installations.

R-W "TWIN-TRAK" SYSTEMS PROVE TO BE ECONOMICAL TO INSTALL, OPERATE AND MAINTAIN

The development of the R-W "TWIN-TRAK" System proved that it is not necessary to spend large amounts of available capital to realize greater efficiency in the handling of materials. Some manufacturers incorporated their existing R-W "ZIG-ZAG" Systems into an automatic "TWIN-TRAK" System . . . an important cost saving factor. Many manufacturers who, for various reasons, did not want to install a complete plant-wide system at one time have found it advantageous to have their "TWIN-TRAK" System installed in progressive steps . . . thereby attaining the desired end result of a complete system as capital is available. R-W "TWIN-TRAK" Systems are easy and economical to install, expand, alter or relocate.

NEW DESIGN DEVELOPMENTS AND SIMPLIFICATION NOW PROVIDE EVEN GREATER ECONOMY AND EFFICIENCY

The immediate success and acceptance of the R-W "TWIN-TRAK" Overhead Automatic Dispatch System spurred R-W Engineers to develop progressive and realistic simplifications of the many components to provide even greater economy and efficiency. Many of the already very effective carriers and manual or electronic switches were simplified and made more compact to save space and cost. Some of the original components were replaced by a new series of both manual and electronic switches that were developed to provide the utmost in positive and reliable operation. A new approach to the treatment of gravity was developed . . . this arrangement makes possible the absolute control of all carriers on gravity feed lines.

LEARN HOW AN R-W "TWIN-TRAK" SYSTEM CAN SOLVE YOUR MATERIALS HANDLING PROBLEMS.

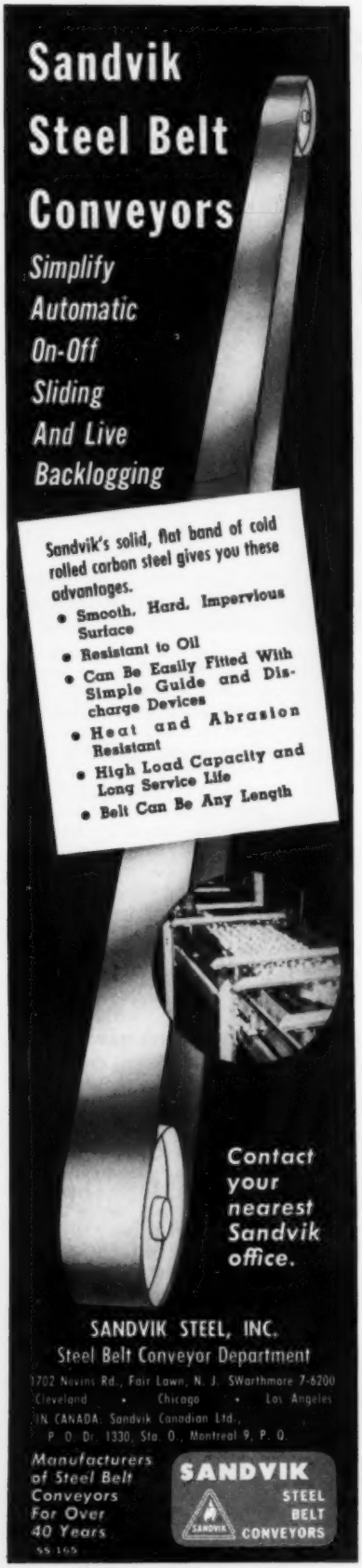
An R-W "TWIN-TRAK" Overhead Automatic Dispatch System not only reduces operating and overhead costs and increases production efficiency but can actually pay for itself, in a relatively short period of time, out of actual savings. Write today for complete information or call your local R-W Sales Engineer.

* "TWIN-TRAK" is the trademark of Richards-Wilcox Manufacturing Co., identifying its Automatic Dispatch System.

Richards-Wilcox MANUFACTURING COMPANY "MATERIAL HANDLING DIVISION"

417 W. THIRD STREET, AURORA, ILLINOIS • Branches in Principal Cities

Circle 702 on Page 139


Sandvik
Steel Belt
Conveyors
Simplify
Automatic
On-Off
Sliding
And Live
Backlogging
Sandvik's solid, flat band of cold rolled carbon steel gives you these advantages.
• Smooth, Hard, Impervious Surface
• Resistant to Oil
• Can Be Easily Fitted With Simple Guide and Discharge Devices
• Heat and Abrasion Resistant
• High Load Capacity and Long Service Life
• Belt Can Be Any Length
Contact your nearest Sandvik office.
SANDVIK STEEL, INC.
Steel Belt Conveyor Department
1702 Nevins Rd., Fair Lawn, N. J. SWarthmore 7-6200
Cleveland • Chicago • Los Angeles
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Manufacturers of Steel Belt Conveyors For Over 40 Years
SS 165
SANDVIK
STEEL
BELT
CONVEYORS
Circle 703 on Page 139

surized coolant reservoir and filter. A range of settings from superfine mist to heavy spray is possible with the precision needle valve control in the jet. Atomizing takes place in the jet tip. One unit can supply up to 10 or more jets by branching from existing lines. The pressurized coolant reservoir can be mounted in any location. **Bijur Lubricating Corp.**, 151 W. Passaic St., Rochelle Park, N. J.

Circle 462 on Page 139

Magnetic Contactor

Item 463

Device features faster inspection by making all parts readily accessible. All moving and stationary contact surfaces are exposed by snapping open the contact cover. Coils are changed by disconnecting the coil leads from the terminals and depressing from the holder. A deceleration arm reduces bounce and lengthens contact life. The self-aligning movable contacts provide equal pressure and alignment between stationary and movable contacts on breaking. As a safety measure, the armature can be locked in the open position, giving a visual indication that the circuit is open. Contactor is available in sizes zero through 5. **Rowan Controller Co.**, 2315 Homewood Ave., Baltimore 18, Md.

Circle 463 on Page 139

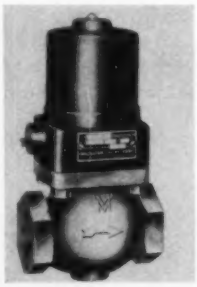
Pressure Transducer

Item 464

Designed for precise measurements of fluctuating or steady state pressures in liquids or gases, pressure measurement instrument uses an unbonded strain wire principle. The transducer is used for pressure measurements in hydraulic and pneumatic lines for applications such as the monitoring of chemical and petroleum processing vessels. The unit can also be used with recording, indicating, or telemetering systems.

In operation, the unbonded strain gage windings are connected in a four-arm bridge around a six-sided diaphragm. Any pressure against this diaphragm produces a displacement of the sensing element, changes the strain gage resistance, and varies the electrical output in proportion to the applied pressure. The instrument is insensitive to vibration and acceleration, and there is a minimum thermal shift due to temperature change. The unit is supplied in ranges of 25, 40, 100, 150, 200, 250, and 300 psi for performance in temperatures ranging from −100 F to +300 F. **Gulton Industries Inc.**, 212 Durham Ave., Metuchen, N. J.

Circle 464 on Page 139



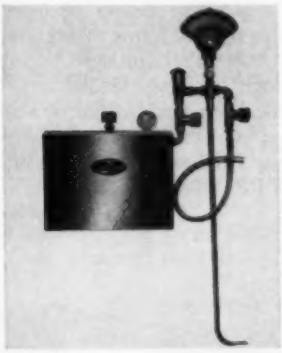
Vibrationless Valve

Item 465

Suitable for the automatic remote control of liquids and gases used in space heating systems and for other industrial applications, vibrationless valve can handle steam, liquids, and gases at temperatures up to 400 F. The valve is single seated, closed by a resilient disc suitable for high temperature service. At low or no pressure, the solenoid alone will actuate the valve for fluid passage. Valve port areas are equal to nominal pipe size. The solenoid is operated through a rectifier supplied with the valve. The valve is normally closed and opens when energized. When closed, line pressure is on top of the disc to give

a positive shut-off. **Magnatrol Valve Corp.**, Hawthorne, N. J.

Circle 465 on Page 139

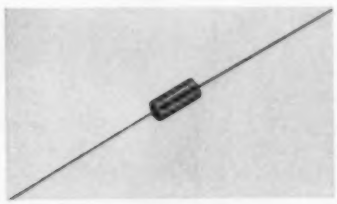


Temperature Control

Item 466

Instrument can automatically adjust and compensate for water temperature within ±¼ F. Temperature control consists of a motor unit containing liquid-filled thermostatic elements and a pressure stabilizing and compensating mechanism, two pressure regulating controls, a pressure gage, volume control, and a vacuum breaker. Thermometer has a phosphorescent pilot and indicating needle which is actuated by a liquid-filled stainless steel bulb. After initial adjustments are made, variations in water temperature are automatically compensated for, and the water temperature at the outlet remains constant at the preset temperature. Controls will deliver from 6 to 125 gpm at water pressure of 45 psi. Unit is available in five different models, with pipe size from ½-inch to 2 inches. **Oscar Fisher Co. Inc.**, P. O. Box 426, Newburgh, N. Y.

Circle 466 on Page 139



Silicon Diodes

Item 467

Automatic machine assembly on printed circuit boards is possible with axial lead silicon diodes. The units are not position sensitive, and

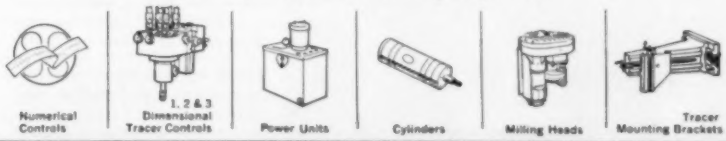
Helping Leading Manufacturers Give You Better Machine Tools!

We at True-Trace are proud to be a part of and contribute to the above manufacturers' reputation in producing accurate, dependable tracer and numerically controlled machines–equipment that can be counted upon to produce the precision, complex parts so vital in today's metalworking industry. These leaders know they can depend upon True-Trace machine tool controls to do the best job. After complete investigation of various control systems available, they, with others, have selected True-Trace as original equipment.

When you think of new machinery for your plant expansion or modernization...look to these leaders for quality equipment you can count on. Or–if you're considering the conversion of existing manual machines to tracer or numerical control...do as the leading machine tool builders have done–specify True-Trace!

"More True-Trace Machine Tool controls are used as original equipment by more machine tool builders than all other control systems combined."

"Sponsor of the Contour Machining Conferences"



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Branch Plants: 35 Urban Ave., Westbury, Long Island, New York
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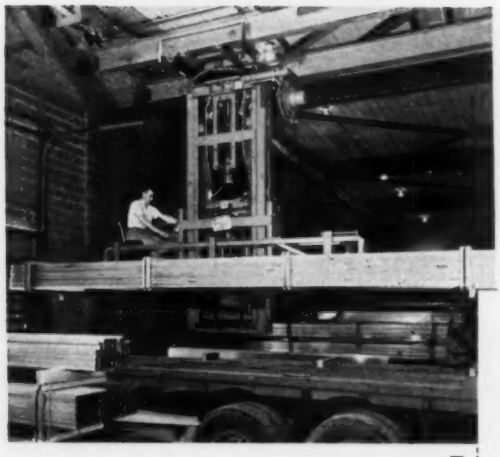
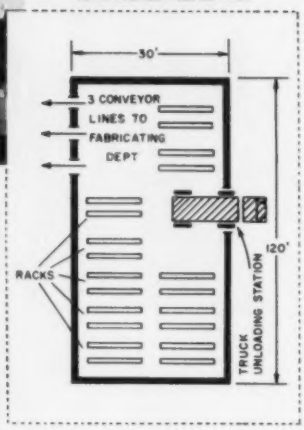
Dealers in Principal Cities

Circle 704 on Page 139



1 MAN ...and TRAK-RAK



handle complete warehousing operation

UNLOADS TRUCKS, STORES MATERIAL IN 1 OPERATION

When the Per-Fit Products Corp., Indianapolis manufacturer of aluminum windows installed a Chicago Tramrail TRAK-RAK unit in its warehouse, it gained 4 big advantages:

1. **Increased the capacity of existing storage area.**
2. **Reduced handling costs by permitting 1 man to handle the entire warehouse.**
3. **Kept production lines supplied with on-time material deliveries.**
4. **Handled high grade aluminum extrusions without damage.**

The TRAK-RAK unit installed at Per-Fit consists of a 1 Ton capacity underrunning crane from which is suspended an electrically operated rotating telescoping column which is fitted with a three-fork carriage. All operations of the TRAK-RAK unit are controlled by the operator, who rides with the carriage. The unit serves a series of self-standing racks equipped with arms which receive the bundled material. Because the TRAK-RAK column requires minimum operating space, the aisles between racks are very narrow.

Trucks delivering material are unloaded (top picture) by the unit, which moves over the tops of the racks (below) to the proper rack and deposits its load in 1 operation. When a particular bundle is required by production, the operator moves to the rack, picks up the bundle, and, moving overhead, travels to the conveyor lines (drawing) and sets the bundle down on the designated conveyor line.

TRAK-RAK Systems of vertical storage and handling are saving time and money in warehouses and production plants of all types. *For complete details on how TRAK-RAK can help solve your problems, write:*

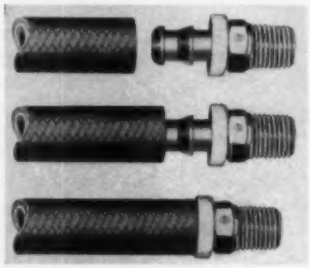
CHICAGO TRAMRAIL CORPORATION

1306 S. Kostner Avenue • Chicago 23, Illinois

Circle 705 on Page 139

can be inserted by automatic machines on an assembly line basis. A built-in heat-dissipating path from the diode junction assures heat transfer. A power rating of up to 200 mw at 25 C can be achieved. Diodes feature a low saturation current, steady voltage regulation through abrupt breakdown, and physical size within that of a standard 1 w resistor. **U. S. Semiconductor Products Inc.**, 3536 W. Osborn Rd., Phoenix, Ariz.

Circle 467 on Page 139

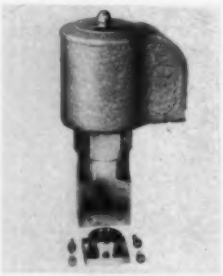


Push-On Hose Ends

Item 468

Units are suitable for a wide range of industrial low pressure applications such as vacuum gage lines. Installation is simple — the hose is pushed onto the barbed inserts and it is ready for use. The design of the barbed insert provides a positive-grip leakproof seal which can withstand working pressure up to 250 psi with a minimum burst pressure of 1000 psi. Sizes from 1/4-inch through 3/4-inch ID are available. **Ft. Wayne Div., Weatherhead Co.**, 2310 Dwenger Ave., Ft. Wayne, Ind.

Circle 468 on Page 139



Vacuum Solenoid Valve

Item 469

Unit is adaptable in automatically operated vacuum systems as

a safety device and as a remote control valve. The moving member is entirely enclosed within the valve body, eliminating stem leakage. The seat seal is made by a nonmetallic O-ring set into one of two units that comprise the valve disc. When the valve is closed, these units are forced apart by a wedge action, pressing the O-ring against the machined brass bar body.

A straight-through design provides a high flow conductance. In the open position, the stem withdraws the disc entirely into the upper part of the valve so the unit can be placed in lines larger than ¾-inch OD with minimum flow restriction. Unit is rated for 115 v ac, the holding current is 0.5 amp, inrush current is 3 amps. **Veeco Vacuum Corp.**, 86 Denton Ave., New Hyde Park, L. I., N. Y.

Circle 469 on Page 139

Transistor Amplifier

Item 470

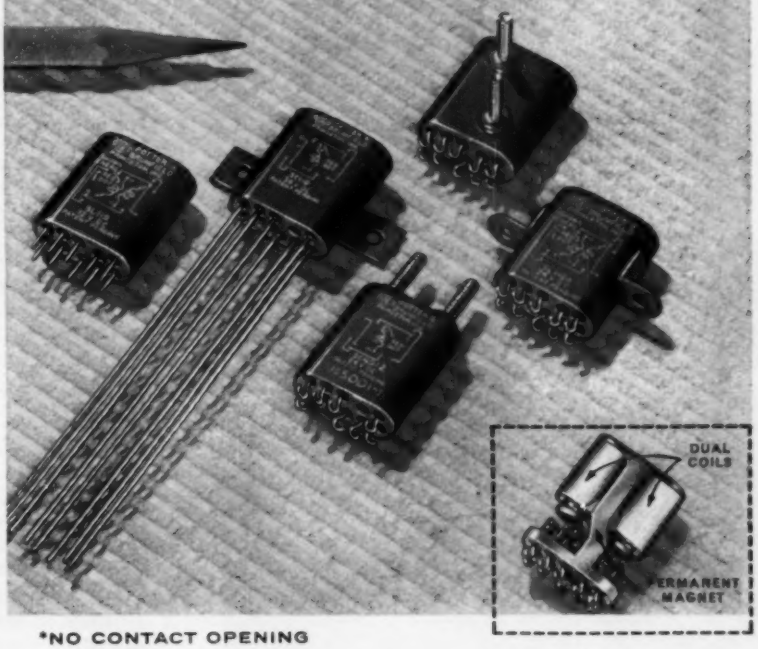
Model 207S is a high temperature, medium gain voltage amplifier designed for servo, audio, and pulse applications. It is capable of gain stability over a range of operating temperatures from −60 C to +160 C. Power requirements are 28 v at 1 ma; open loop gain is over 40 db. The gain is achieved through a circuit which uses dc feedback to stabilize the operating point and ac feedback to achieve good wave form and broad bandwidth. A built-in current limiting device protects the unit from damage by short circuited output or by reversing power supply polarity. Enclosed in a stainless steel case, unit has a vibration specification of 400 G at 2 kc without microphonic noise. **Electronic Div., Taber Instrument Corp.**, 107 Goundry St., North Tonawanda, N. Y.

Circle 470 on Page 139

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

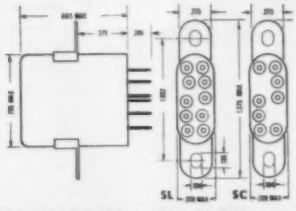
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g
Temperature Range:—65° C. to +125° C.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS max. with 550 ohm coil @ 24 V. DC (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.

CONTACTS:
Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.

COIL:
Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.

MOUNTINGS:
Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

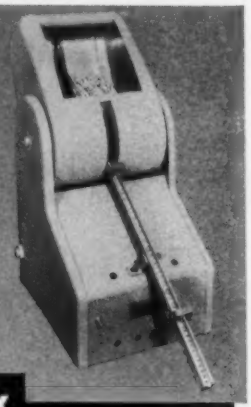
Circle 706 on Page 139

HOPPERAL

something NEW in small parts feeders

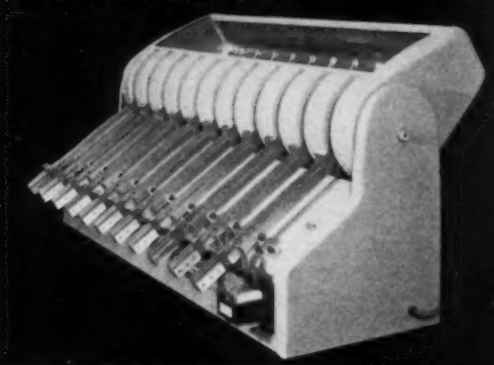
SINGLE TRACK

Orients and releases one or more parts in a single, smooth, sliding motion. Lifts part to track with a minimum of vibration or tumbling action. Fast, versatile, self-contained



MULTIPLE TRACK

Available with any number of tracks to feed parts to assemblies or other operations where a large quantity of parts is required simultaneously. Can be partitioned and supplied with properly designed tracks to feed unlike parts



HOPPERAL DRIVER

Can be equipped to drive small nails, drive screws, pins, rivets, roll pins and a multitude of similar parts. Will feed small parts for assembly requiring staking, press fitting, peening and riveting

Write for further information about these automated feeders and assembly machines.

HABERSTUMP-HARRIS, INC.

10463 Northlawn Avenue • Detroit 4, Mich.

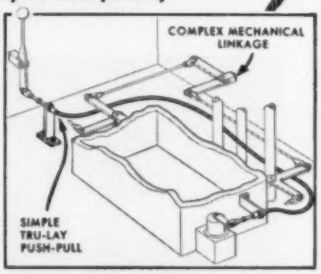
Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when conduit is COMPLETELY IMMERSED.

Lubrication of the inner working member is for life.

Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

Our **DATA FILE** *will answer your further questions. Write for a copy without obligation*

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Automotive and Aircraft Division
AMERICAN CHAIN & CABLE

TRADE MARK

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Circle 707 on Page 139

Circle 708 on Page 139

AUTOMATION abstracts

TRENDS IN AUTOMATION AND PRODUCTION EQUIPMENT

By JAMES C. KEEBLER
Managing Editor

TO CONSIDER machinery and automation, the subject can be approached from two points of view: 1. What's going on with automation and how does this affect the design of production machines. 2. What's going on in the development of production machines and how does this affect automation. Realizing the importance of the state of the art of machinery design in establishing automated production processes, and the importance of considering automation's requirements when designing machines, it is well to look at both viewpoints of the subject: Machinery and Automation.

Trends in Automation

Certain historical developments of machine shop work can throw light on the present trends in automated production. The blacksmith made one part. The early machinist did likewise with the help of his machine tools. This machinist was a toolmaker too and made the necessary tools to make the required parts.

Repeat orders necessitated improved engineering drawings to record what had been made. Improved engineering and drawing techniques led to machine and product design being performed on the drawing boards prior to making parts. Machine shop activity increased and the advent of the Yankee Toolmaker saw a separation of toolmaking from production machining. Problems of tool maintenance, duplication, and repair led to tool drawings to record what the toolmaker had done. As the tool engineer evolved out of this situation he learned to design, on paper, tools that could be built to his prints.

Long range industrial trends have shown production planning responsibility coming out of the machine shop and being established in the engineering departments. It was a logical step to have production sequences recorded on paper so that the knowledge gained in a run of production parts could be used effectively when it became necessary to make similar parts again. Men employed to handle this type of paperwork were next called upon to determine new production processes in advance of setting up to run new parts. This has come to be known as process planning, manufacturing engineering, production engineering, or as simply the role of the master mechanic. This function that was once handled by the shop foreman, and considered in educational circles to be trade school stuff, is now emerging into the full blown stature of an engineering activity.

Oldtimers will tell you that not only has the process planning function left the shop floor, but skilled machinist-mechanics are as scarce as hen's teeth. The hand turret lathe operator who seemed to dance in harmony with his machine cycle, knew how hard to

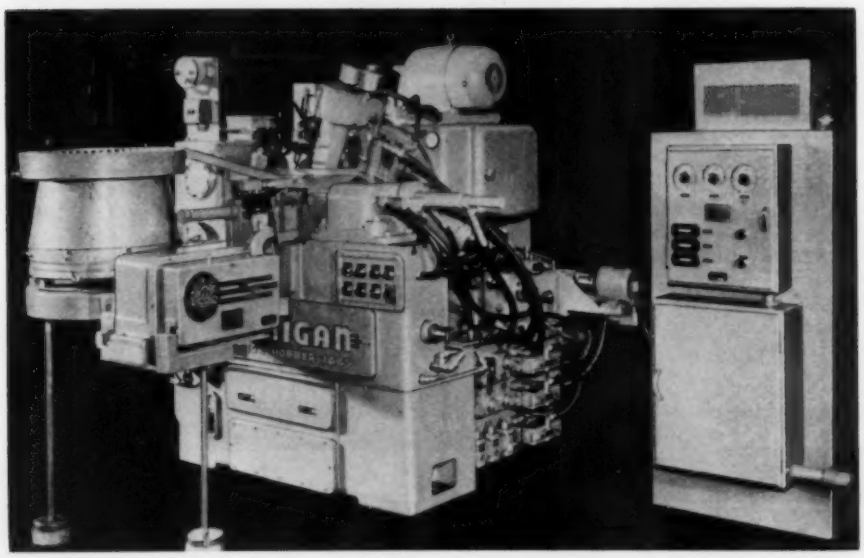

Fig. 1—Gear hobbing machine is equipped with hopper feeder, automatic size classifier, and size controller. Controller shuts down machine when predetermined gear production is reached or if an excessive number of rejects occurs.

Courtesy, Michigan Tool Co.

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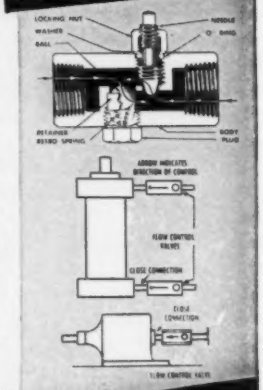
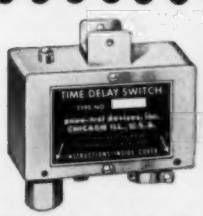
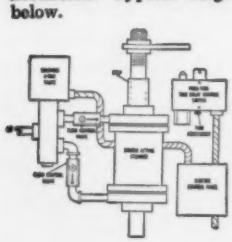


TIME DELAY CONTROL SWITCH FOR PRECISE DELAY OF WORK CYCLE



Provide controlled adjustable time dwell of solenoid operated air or oil supply valves. Range between ¼ and 60 seconds in 20 to 1 ratios. Compact—simple—foolproof—rugged Easily mounted on machine. Available for various types of actuation. Typical diagram below.



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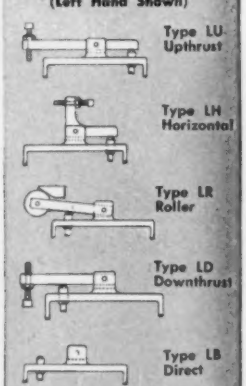

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hit the stops, could find size and whirl the carriage out of dwell, has been replaced by the kid from the drill presses who runs the machine like he's got two left arms. Supervision can see no way out of the problem but to get a single spindle automatic chucker whose slides do the same thing no matter how hard you push the button.

The shortage of machinists with skilled hands is by no means the sole incentive to create more automated production operations. Competition at the marketplace has placed added emphasis on product quality. Expanding market potentials have placed a premium on the ability to produce in large quantities. Development of new product lines provides the challenge and the opportunity to establish production facilities that are as automated as the known state-of-the-art will allow (a case in point is the electronics industry where George F. Metcalf of General Electric Co. has predicted that one-third of the products available in 1965 will result from technology unknown and unsuspected in 1955). Each of these trends gives a strong push to the advancement of automation, but the greatest single factor appears to be the need to make products for less cost.

Process Engineering

The processing engineer of today is expected to provide the necessary production processes, machines, tools, and paperwork to enable the shop to get out the required production as automatically as possible. He must dream up new processes to make new products and put his production equipment into operation with the mini-

Courtesy, Michigan Tool Co.

Fig. 2—Circulating conveyor system acts as in-process storage bank for Heald internal grinder that grinds ID of cones for tapered roller bearings.

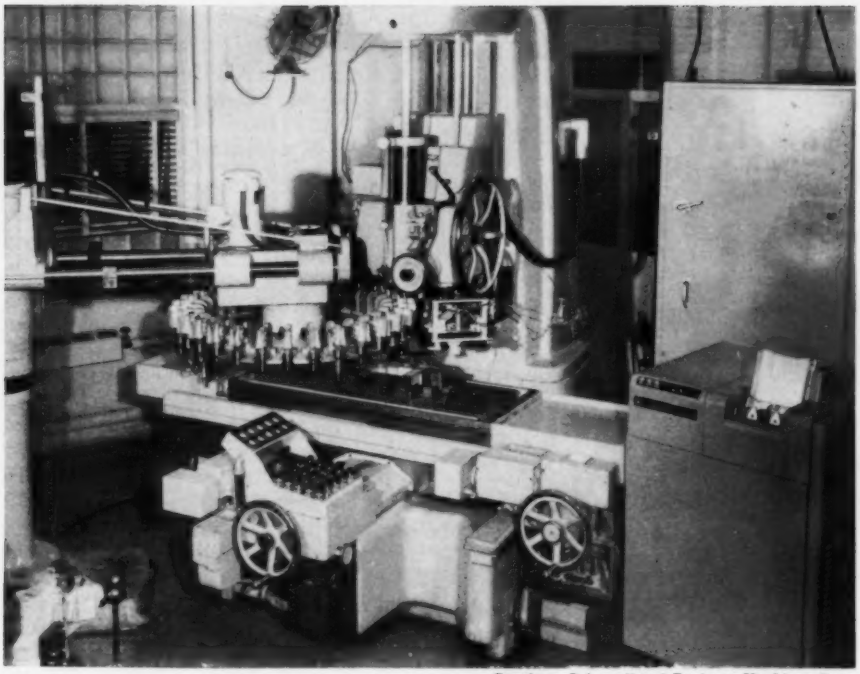

Fig. 3—Fosdick jig borer has been equipped with a punched card control system that programs all machine actions including automatic tool change.

Courtesy, International Business Machines Corp.

mum of "cut and try" process development work. Besides a thorough background of manufacturing techniques he must know his (and the potentially available) equipment and the components of which it consists.

The responsibilities and scope of process engineering for a given machine shop usually involve: 1. Establishing the factory routing for all parts to be machined, finished, and assembled. 2. Providing a tooling plan

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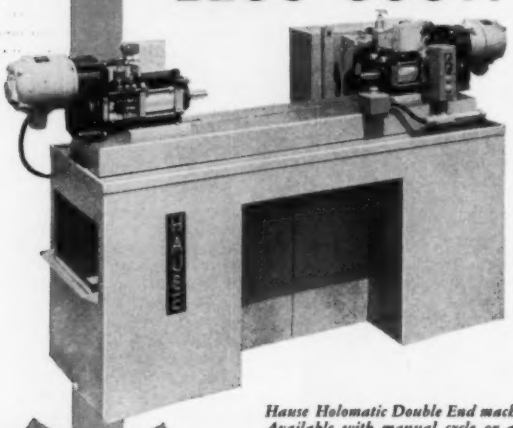

Hause Holomatic Double End machine. Available with manual cycle or automatic—interlocked control systems.

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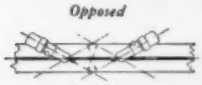

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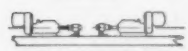

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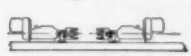

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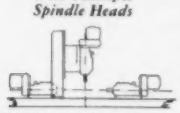

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for each operation on each part. 3. Procuring the necessary tool designs and tools that are required by the tooling plan. 4. Keeping score on these activities with an appropriate paperwork system. As in the entire business enterprise, automation thinking enters and alters each phase of the processing engineer's work.

Factory Routing

In establishing the factory routing, the sequence of operations that will make the parts as automatically as is economically feasible is the goal. This thinking involves determining what production operations are required and in what order they should be performed. In making these determinations the processing engineer draws on his general knowhow of good production practice and experience he has gained by observing and studying the manufacture of similar parts. Machining dimensions and tolerances must be worked out for each step of the process to assure that the completed parts will meet the part print requirements.

Machines are selected for each operation on the routing. Here a wide variety of factors enters into the selections. If the manufacture of the parts in question represent activity of a company's expansion program and new machinery is being acquired for these routings, the field is wide open to choose, in each case, the machine that is best suited to the operation. But the facts of life rarely present such golden opportunities and other complications usually enter into the picture. One may be a model changeover program where certain machines will be made available from present production and offer cost advantages if worked into the new routing. Greater complexities may be encountered if the parts in question are to be made in job lots in production runs sandwiched between other part lots on as many of the shop's existing machines as have the open production time to handle this new work.

Whatever the production requirement situation that is present for a given factory routing there are considerations of machine selection that are based on experience with automated production: Can this operation be done best on an automatic cycling machine? Can these automatic cycling machines be linked by handling devices to form an automatic line? Can automatic lines be integrated to form automated production?

Depending on the required sequence of operations, the ramifications of quantity and duration of production, plus the degree of automatic operation deemed desirable, the machinery chosen might include a transfer machine to perform all the required machining on one large multistation machine tool, or a line of presses with automatic loaders and unloaders to move the parts along to conveyors that transport them through cleaning and finishing equipment. On the other hand, the production might be handled on a collection of standard machine tools that are hopper fed and automatically eject their output into other hoppers. Maybe a completely special machine is the answer.

The Tooling Plan

In making up a tooling plan for a given factory routing each operation must be provided with: 1. Jigs, fixtures or dies that support or restrain the part while the operation is being performed. 2. Cutting tools or

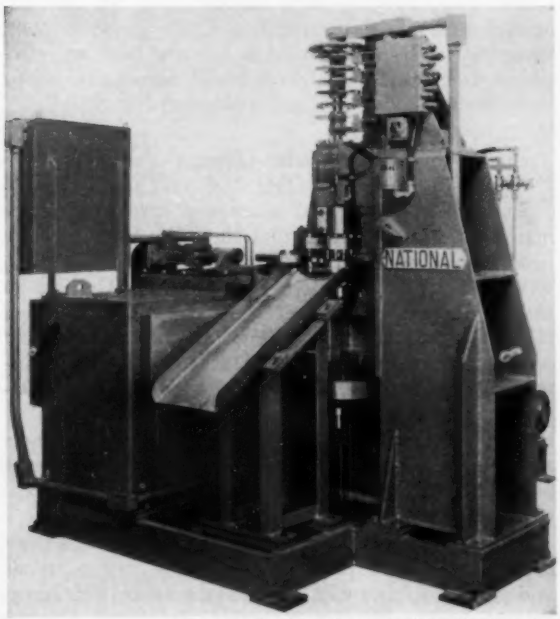
Circle 711 on Page 139

punches that do the actual work on the parts. 3. Gages to check that the operation was done properly. 4. Handling devices to move the pieces to and from this operation.

Before automation thinking entered tool planning, jigs and fixtures were mostly hand operated. Now the trend is to have a motion of the machine either operate the fixture directly or trip the control mechanism that signals the actuator that operates the fixture. Cutting tools have been mechanically held in the machine for years but fear of downtime of automated equipment has led to designs that provide for quick change of dull tools.

Gaging has always represented a compromise, based on the tool planner's judgment of what dimensions are critical enough to warrant the expenses for gages and inspectors' time. These costs were weighed against the consequences of having parts that are unacceptable on critical dimensions go on to subsequent operations. Now the trend toward more automatic operations involves automatic gaging stations, either built into the machine or as a separate gaging machine between machines. These stations may merely inspect parts or may also send control signals to the machine. Gaging is now often required for another reason, which was created by automatic operating fixtures and handling devices. Formerly offsize parts or those with missed operations could be detected by the operator as he loaded the part. But with automatic equipment the story is different. Unless a gaging operation is included to prevent such parts from continuing on their way they may cause costly jamming of equipment.

As automation techniques developed, tool planners saw the need to include handling devices on the list of tooling to be considered for each operation. Hand



Courtesy, National Electric Welding Machines Co.

Fig. 4—Welding joins the list of automated operations in this brake shoe forming and welding machine. Rims are loaded in a flat condition and formed simultaneously with the welding operation.

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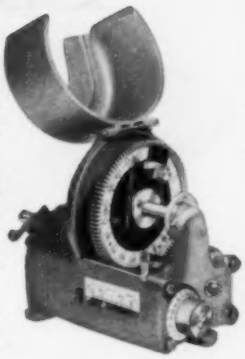

WHAT IT DOES: The "Cyclo-Monitor" momentarily opens or closes electric circuits to motors, magnetic brakes, signals, relays, solenoids, etc., based on a predetermined count. Repeats automatically—no count reading, checking or manual re-setting between cycles.

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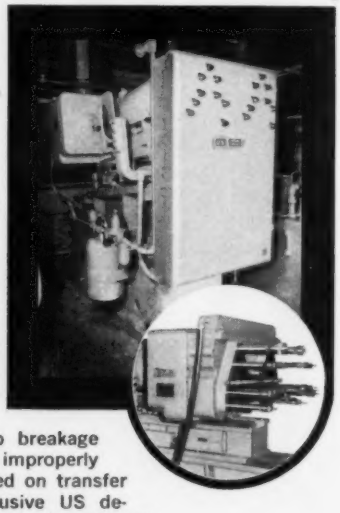
The U. S. Drill Head Co.'s new electronic device seeks trouble too—in automated production lines. It locates faulty machining during a "transfer setup" and stops the machine *before* succeeding operations are begun. It minimizes the chance of costly smash-ups and resulting expensive down-time . . . reduces re-operating and scrap-loss costs.

It is another precision cost-reducing "tool" from the largest exclusive drill head builder in the world.



US Individual Lead Screw Tapping Head automatically signals on a light panel exact location of any spindle not tapping to full depth, and stops the entire line. In addition, patented US Safety Tap Spindles prevent all tap breakage due to dull taps or improperly drilled holes. Installed on transfer machines, this exclusive US development provides dual automatic protection during tapping without need for an extra probing station.

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loading and unloading is inconsistent with the need for efficient utilization of productive manpower. Basic handling equipment can be provided with special fingers, pawls, or hooks that make it adaptable to different production parts.

The processing engineer's efforts to devise a good production process, utilizing automatic machinery and tooling, will meet with little success unless backed up by tool engineers who can transform the plans into workable tool designs. They must know their machines, how they cycle, and how the various tooling components they are designing can tie into the machine to function as an interlocked part of that machine with maximum safety and efficiency. This may be too big a task for the employees of the user firm. Assistance is being sought from consultants, tool design shops, control specialists, and from the machinery builders themselves—organizations with the background and experience to tool up for automation.

Engineering Paperwork

How much of the equipment involved is new, and how much is tied into existing facilities, is a large factor in establishing the amount of co-ordinating effort that is required on the part of the processing engineer. If the program involves a new transfer machine to completely process the part in question, the machine tool builder who gets the job will take on the whole task and leave the customer with a minimum of paperwork to handle. Buyers in such cases differ in the amount of drawings they require for their files. To cope with machine maintenance, part-print revisions, and retooling programs the user would do well to have a rather complete set of prints. Suppliers also vary in their thoughts on the matter. Often the machine contains features they'd rather not disclose, and besides, if the prints furnished the customer are too complete he may decide to buy the next one elsewhere. It is well to make clear-cut agreements about design drawings before starting the work.

Trends in Production Machine Design

Study of the design of automated systems or automated machinery reveals that there are three primary functions to consider: 1. Work performing. 2. Handling within, and between, work stations. 3. Control to integrate work performance and handling. Each of these functions has a bearing on equipment design and none should be ignored. Since the popular industrial concept of automation can simply be stated: "Doing the job more automatically than we've been"—it follows that a machine that does none of these three functions automatically and is upgraded to do any or all of them automatically can truly be said to have been automated.

Some examples of machinery developments will illustrate some of the production machine design trends and point out how they affect automation. The transfer machine represents a highly developed type of automated machine which has seen its greatest service in the automobile industry. Transfer machines come in all shapes and sizes, but the distinguishing features are multiple work stations, all of which cycle simul-

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Automatic turn selection from 1 to 2,000. Completely automatic during winding cycle.

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Illustrated is simultaneous winder with tap pulling attachment for 2-pole shaded pole motor stator.

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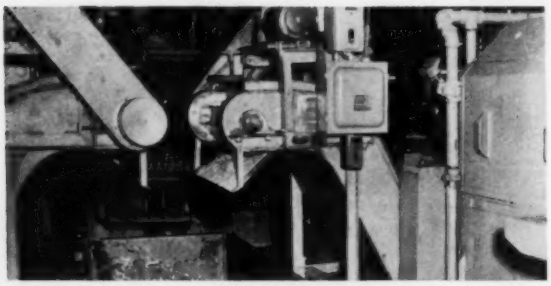
MAY-FRAN CHIP-TOTES



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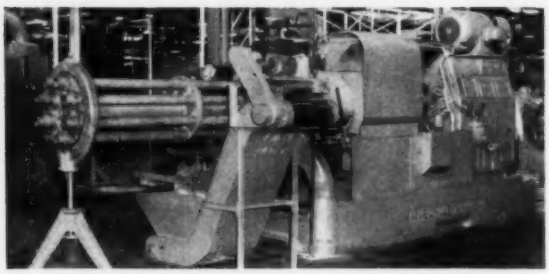

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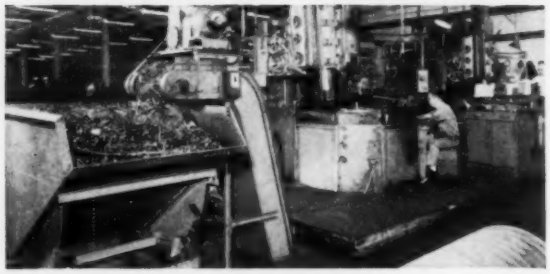

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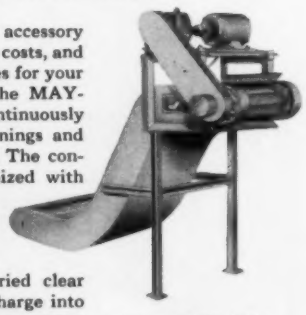

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taneously to perform their work and return to their retracted position, at which time the workpieces are all transferred to the next work station and the machining cycle repeats. Considerations for use in automation are the advantages of automatic cycling and automatic handling between work stations. Possible cautions include: Decision as to how many stations to link together between parts storage, since all stations are idle when any one is shut down; necessity to purchase a pallet-fixture for each station plus enough to fill the return conveyor if the part is such that it cannot be shoved between work stations and be easily reoriented.

Straight line and rotary transfer machines are so firmly established in the automobile industry that Ford, General Motors, and Chrysler representatives have had conferences with 26 suppliers of such machines, and are developing standards for mounting surface patterns and work heights.

An illustration of a standard machine tool equipped with hopper feed, automatic eject, and built-on automatic gaging that corrects size setting after classifying the part just completed is the Michigan Tool hobbing machine, *Fig.* 1, which is ready for service in an automated line.

One method of supplying workpieces to a battery of machines performing a given operation is to use a circulating conveyor system as an in-process storage bank. Such an arrangement is used with Heald internal grinders, *Fig.* 2, at Timken's Bucyrus plant. The operation shown automatically grinds the ID of cones for tapered roller bearings.

At New Departure Div., General Motors Corp., ball thrust bearings for refrigerator hinges are assembled on a specially tooled V&O press. A dial indexing table handles parts between work stations and a hopper feeds parts to the assembly positions. Assembly machines present a large challenge for the machine builder to provide standard machines adaptable to different requirements.

Tape and cards can provide flexibility of control that holds great promise for programming the automatic cycle of machinery. The number of different machine functions that can be included in a program is dependent on the ingenuity of the designer and the economics of the situation. A Fosdick Jig Borer, *Fig.* 3, has been equipped with an I.B.M. system that not only controls all operating phases of the machine cycle but changes tools automatically as well.

Welding techniques are being incorporated into automated machines. Automotive brake shoes are formed and welded on a machine built by National Electric Welding Machines Co., *Fig.* 4.

The processing engineer follows closely the developments in production machines for they are the framework upon which his production process is built. The two factors are interdependent: Factory routing decisions are influenced by available machines and their capabilities; production machine design developments are based on the changing needs of the factory routing requirements.

From a paper entitled "Machinery and Automation" presented at the 26th Annual Meeting of the American Society of Tool Engineers, Philadelphia, May 1958.

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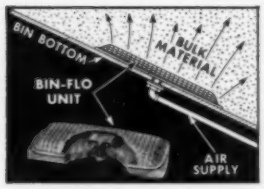

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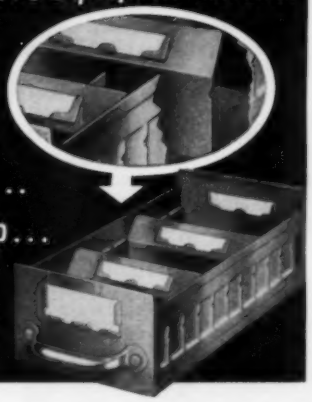

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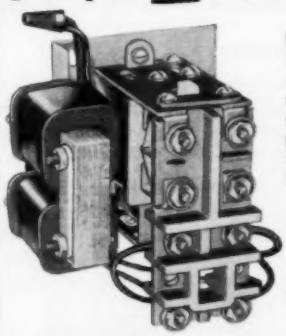

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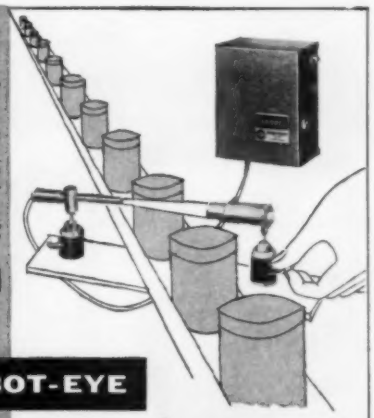

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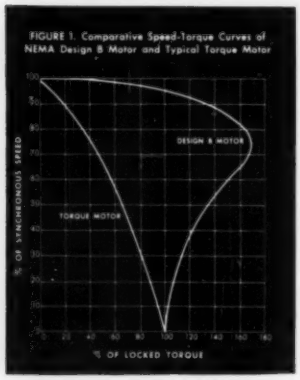

FIGURE 1. Comparative Speed-Torque Curves of NEMA Design B Motor and Typical Torque Motor

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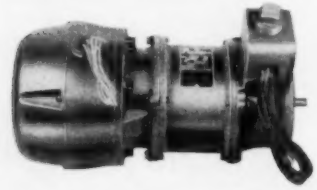
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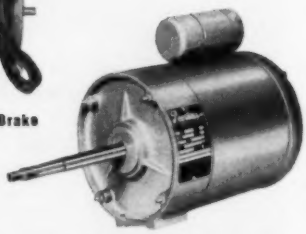
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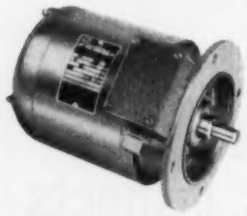
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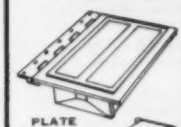
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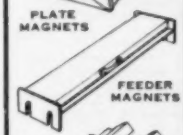
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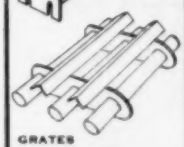
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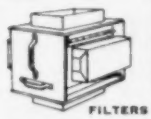
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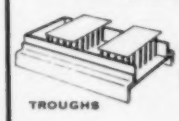
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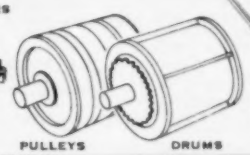
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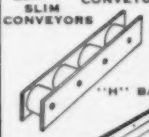
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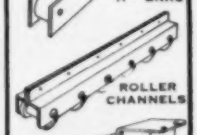
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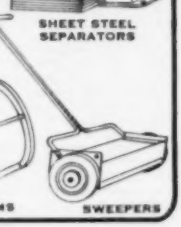
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CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Accounting, 5-60
Actuators, hydraulic, 3-86
Adiletta, J. G.
  Comparing Machine Cost and Time Factors, 5-55
Air blending, 3-14
Amplifiers, transmission circuits, 2-84
Analysis, instrumental methods, 3-156
Application,
  proximity transducers, 2-69
  transistor circuits, 2-84
Assembly,
  automated, 1-52; 3-9; 5-10
  diode sealer, 4-10
  electronic components, 3-58
  gravity conveyors, 6-40
  of darts, problem, 6-134
  principles, 1-58
  roller bearings, 2-57
  small motors, 3-9
  sponge mops, 4-17
Automation,
  and labor, 2-19, 52; 3-12; 4-150
  and management, 5-156
  and paperwork, 3-65
  and plant size, 4-147
  and supplemental unemployment benefits, 2-52
  and the community, 4-150; 6-10
  and the economy, 3-154
  for small-lot producers, 3-54
  importance of handling, 5-40
  in automobile industry, 4-12
  in coal industry, 6-12
  in colleges, 4-10, 17
  in food industry, 5-14
  in industrial instruments, 4-12
  in pipeline industry, 4-10
  in railroads, 2-12; 6-9
  movies on, 5-19
  numerical positioning control, 4-60
  numerically controlled machine tool system, 6-34
  philosophy, 1-141; 3-154; 6-121
  planning for, 1-37; 3-54; 6-121
  trends in, 6-121
Automobile,
  bodies, 3-93
  crankshaft balancing, 2-80
  parts manufacture, 5-43
  seats, 3-93

B

Bakery operations, 2-91
Bale, A. G., Jr.
  Automatic Batching System Combines Flexibility and Portability, 5-76
Banking between operations, 1-59
Banks, automation in, 12-9
Batch weighing, 5-76
Bauer, J. H.
  Production Line Welding, 5-68
Bearings,
  manufacture, 2-57
  roller way, 4-28
Bill changer, 2-12
Binding paper rolls, 6-49
Blending control, 3-94
Blending dry materials, 3-14
Blower wheels, 5-74
Bols, R. W.
  Idle Time, edit., 6-33
Breadwrapping machines, 5-55
Browning, E. H.
  Strip Mill Uses Automatic Programmed Control, 6-64
Bulk handling, 3-16, 94; 5-76

C

Centralized control, 6-9
Charging thermostatic units, problem, 1-138
Clark, E. C.
  Numerical Positioning, 4-60
Cocks, E. H.
  Automatic Spray Painting of Electrical Conduit, 3-69
Coding mail, 5-12
Communication type controls, 3-82
Computers, 5-68
  analog, 3-20
  auto guidance, 4-39
  for absorbing articles, 4-14
  for airlines, 1-14
  for flood control, 2-12
  for inventory control, 3-10
  for process control, 5-22
Conduit painting, 3-69
Constant speed motors, 1-85
Controls,
  atmosphere in furnace, 4-81; 5-46
  auto steering, 4-39
  automatic balancing, 2-80
  building blocks, 6-34
  continuous process, 1-14
  design to be foolproof, 3-43
  electrical power supply, 1-14
  electrohydraulic, 6-69
  electronic, 2-150
  electropneumatic, 3-33, 78; 5-91
  gaging, 3-73
  glass melting, 3-16
  heat treating, 5-46
  interfloor conveying, 4-69
  machine tools, 3-27; 4-142
  magnetostrictive motor, 4-73
  mechanical-pneumatic, 3-78
  nail feeder, 3-89
  numerical, 2-9, 16; 5-9
  numerical controlled machine tools, 6-34
  of material level, 1-78
  of motor speed, 1-85
  of presses, 3-146
  optimizing, 5-71
  panels, 3-10
  plug-in, 3-82
  programmed tractor, 4-81
  proximity transducers, 2-69
  punched card, 5-79; 6-64
  railroad traffic, 6-9
  remote, 5-91; 6-58
  rolling mill, 6-64
  sequencing, 6-69
  static, 3-75
  stepping switch, 3-89
  theory, 4-139
  traffic lights, 6-10
  transistors in, 2-84; 6-10
Conveyors,
  bottles, 5-12
  bulk material, 2-10
  food industry, 2-91, 93
  interfloor handling, 4-69
  magnetic, 4-12
  making gravity type, 5-40
  overhead, 1-63; 4-57; 5-10
  package, 5-60
  paper rolls, 6-49
  roller bearings, 2-57
  sensing materials on, 2-69
  steel belt, 4-56
  systems, 1-10, 63
  transfer devices, 5-19
Cost estimating, 5-52, 55, 60
Counting devices, 2-25
Cartons, problem, 5-142
Crankshafts, 2-80
Cutoff, tubing, 3-60
Cylinders, pneumatic interlocked, 5-92

D

Data processing, 1-10, 152; 2-14; 3-10, 16, 65; 4-139; 5-68, 156; 6-10
  abstracts articles, 4-14
Data recording, 2-72
Data storage, 2-10; 3-24; 5-24
Data transmission, 2-14, 23
Depreciation, 5-51, 60
Design,
  for automated production, 3-58
  for foolproof automation, 3-43
  for production, 4-139
  numerical positioning control, 4-60
  of controls for reliability, 2-150
  of handling systems, 5-40
  of interfloor conveying system, 4-69
Detectors,
  tramp metal problem, 2-148
Dexter, R. G.
  Estimating Special Equipment Costs, 5-52
Differential transformers, 5-79
Digital,
  computing systems, 4-139
  recording, 2-72; 4-139
Direct magnetic recording, 2-72
Drilling, 3-22
  crankshaft balancing, 2-80
Dynamic balancing, 2-80

E

Economics,
  numerically controlled line, 6-34
Education of automation, 4-10
Ejecting assemblies, 1-52
Elam, D.
  Applying Proximity Transducers, 2-69
Electrical,
  elementary diagrams, 5-147
  machine control, 2-69; 4-82; 5-147
  network synthesis, 6-130
Electromagnets, 1-43
Electronics,
  assembly, 2-16; 3-58
  bill changer, 2-12
  building blocks, 6-34
  component packages, 1-14
  construction system, 4-22
  data processing, 2-161; 6-10
  future growth, 6-10
  improving reliability of, 2-150
  laboratory devices, 2-19
  postal equipment, 5-12
  semiconductor manufacture, 5-10
  testing devices, 6-19
  traffic control, 6-10
  transistor application, 2-84
Elevator, for parts, 1-52
Engineering,
  processing, 6-121
  productivity, 4-139
  scientific background, 1-37
  special machines, 5-55
Engler, W. E.
  Versatile Interfloor Handling, 4-69
Equipment,
  cost estimating, 5-52, 55, 60
  replacement, 5-51
Escapements, 1-52; 2-94
Estimating, 5-52, 55, 60
Experimentation, automatic, 5-71
Extractor, vacuum, 1-154
Extrusion, titanium, 1-12

F

Failsafe controls, 3-43
Fasteners, 5-10
Feeders,
  bar, 1-88
  blank, 1-154
  control, 3-89
  for discrete parts, 5-82
  for setscrews, 4-77
  for small parts, 1-52; 2-25
  molding press, 5-59
  pneumatically controlled, 3-94
  stamping press, 2-10
  transducer controlled, 2-69
Feeding,
  assembly components, 1-52
  discrete parts, 5-82
  electrodes, 2-94
  plastic rope, 5-59
  sheet metal, 5-89
  thin materials, problem, 6-135
Filtering, slurry, 2-92
Fittings, nylon compression, 2-28
Fixtures, for assembly operations, 1-56
Floats, 1-59; 4-56
Flow control, 4-22
  magnetic tape recording, 5-50
Food processing, 2-91
Forging crankshafts, 1-75
Forming, sheet materials, 3-93
Frequency modulated carrier recording, 2-72
Functional testing, 3-61

G

Gaging,
  combined in-process and post-process, 3-73
  components problem, 4-140
  dynamic balancing, 2-80
  in control, 5-144
  in-process, 4-24, 92; 6-16
  liquid height, 1-16, 78
  on machine tools, 1-19
  post-process, 1-81
Garrison, J. L.
  Applying Infrared Analyzers to Control Furnace Atmospheres, 5-46
Gear production, 4-91
Gibbs, R.
  Orientation by Rotation, 4-77
Goldberg, R., 6-25
Gravity conveyor manufacture, 5-40
Grinding,
  control, 3-73
  piston rings, 4-80
Gruber, W. M.
  In-Line Production Balancing, 2-80
Guidance control, of autos, 4-39

H

Hadekel, R.
  Hydraulic Control of Automatic Machinery, 2-63; 4-82; 6-69
Handling, 3-159
  bakery operations, 2-91
  banking, 1-59; 4-56
  between machines, 5-88
  billets, 1-75
  bottles, 5-12
  bulk materials, 2-10; 3-16, 94; 5-76
  by programmed tractor, 4-81
  cases, 3-92; 5-30
  cigarettes, 4-90
  concrete ingredients, 5-76
  conveying, 1-63; 4-57
  crankshafts for balancing, 2-80
  for assembly, 1-52
  for forging, 1-75
  for painting, 4-57
  for woodworking, 5-88
  garment materials, 5-60
  in transfer machine, 4-50
  magnetic, 1-43; 5-12
  mail, 5-12
  pallets, 6-14
  paper rolls, 6-49
  piling bulk materials, 3-85
  pistons, 4-56
  plumbing fittings, 5-10
  roller bearings, 2-57
  scrap, 4-9
  sheet metal, 5-89
  steel bar, 1-88
  to machine tools, 1-59; 4-91
Heat treating, 6-46
Holding, parts for assembly, 1-56
Honing, 4-14
Hydraulics,
  actuators, 3-86
  automatic sequencing, 6-69
  control, 2-63; 6-69
  converted machine tool, 4-81
  press system, 3-75
  systems engineering, 4-82

I

Idling, in hydraulic systems, 4-82
Indexing, devices, 3-86
Industrial engineering, 5-55
Information handling, 2-72, 161; 3-65; 6-10
Infrared analyzers, 6-46
Inspection,
  automatic, 1-59; 5-144
  closed circuit television, 6-58
  crankshaft balance, 2-80
  electronic, 6-16
  photoelectric, 5-12
  testing, 3-61
Integrated,
  data processing, 5-68
  handling, 1-42; 4-91
  standard machines, 6-57
Integrating automatic operations, 1-59; 6-57
Interfloor handling, 4-69
Interlocking, pneumatic cylinders 5-92
Inventions, 6-25
Isotopes in production operations, 1-78
Israelson, A. F.
  Magnetic Handling Devices, 1-43

J

Jessup, W. F.
  Integrated Machine Tool Systems, 4-50

K

Kerstukos, A.
Optimizing Process Operations, 5-71

L

Lathes,
loading problem, 1-138
numerical control, 4-60
Layout and dimensioning, 6-130
Lemelson, J. H.
Guideposts to Automation Planning, 2-52
Liquid filling, 4-30
Load cells, 3-94
Loading, 3-92

M

Machine tools,
card controlled, 4-60
control, 1-81; 3-73, 82
grinding, 4-73, 80
in crankshaft balancing, 2-80
integrated systems of, 4-50
presses, 5-43, 74
rotary index, 4-39
tape controlled, 4-60; 5-9; 6-34
tracer controlled, 4-81
Machines,
assembly, 2-57; 4-10
boring, 2-9
bread wrapping, 5-55
carton stacking, 6-60
circuit board, problem, 3-51; 6-135
compression molding, 5-59
cutoff, 3-60
design trends, 6-121
drilling, 3-92, 93
dynamic balancing, 2-80
estimating costs of, 5-52, 55
extrusion press, 2-19; 6-12
honing raceways, 4-14
numerical control, 2-9; 4-60; 5-9
nutsetter, 4-17
pneumatic, 3-78
powder rolling, 5-10
scrap shear, 4-9
tape controlled, 3-57
testing, 3-61; 6-19
welding, 5-14
wire coating, 4-80
MacWilliams, R. W.
How to Figure Payoff, 5-60
Magnet, belt conveyor application, 4-12
Magnetic,
equipment applications, 1-43
handling devices, 1-43; 4-12
memory devices, 2-10
rubber, 5-12
tape recorders, 2-72; 3-24; 5-9; 6-50
Magnets, permanent, 1-43
Magnetostrictive actuation, 4-73
Management for engineers, 5-130
Manufacture of,
aluminum strip, 2-93
automobile bodies, 3-93
automobile crankshafts, 1-75
automobile engines, 1-63
automobile frames, 1-63
automobile parts, 1-88
automobile seats, 3-93
blower wheels, 5-74
cement, 2-92
cigarettes, 4-90
control components, 6-34
copper coated wire, 4-80
cores, 1-154
finned wire, 1-154
gasket retainers, 6-57
gears, 1-59
gun shells, 3-9
jet engine casings, 5-79
magnetic tape, 1-62
metal parts, 6-130
motors, 3-9
pipe, 3-92
piston rings, problem, 4-140
pulp insulation, 6-58
railroad car wheels, 4-12
road machinery, 4-39
roller bearings, 1-37
washer baskets, 6-68
window frames, 1-63
wood products, 5-88
Manufacturing functions in small-lot automation, 3-58
Materials handling, 1-10, 33; 2-10; 3-16, 24, 156; 4-60, 81; 5-10, 30, 156
application of principles, 5-40
Maynard, A. F.
Automation for Small-Lot Producers, 3-54
McCabe, L. B.
Automation for Small-Lot Producers, 3-54
Measurement, electrical, 3-156
Measuring,
liquid level, 1-78
ultrasonic, 4-22
Memory,
devices, 2-23; 4-20; 5-35
twisted wire, 2-10
Militoto, R. P.
Automation for Small-Lot Producers, 3-54
Milligan, W. E.
Automatic Weighing and Blending, 3-94
Mohr, P. A.
Magnetic Tape Systems for Data Recording, 2-72
Instrumentation Applications of Magnetic Tape Recording, 6-50
Moisture control, problem, 3-57
Molding plastics, 3-12, 75; 5-147; 6-59
Molding wax tires, problem, 1-138; 6-135
Morita, J. M.
Basic Pneumatics for Automation, 3-78; 5-92
Moskowitz, L. R.
Magnetic Handling Devices, 1-43
Motors,
drives, 1-85
reversing problem, 4-140

N

Nail feeding, 3-89
Numerical control, 1-34; 2-16; 3-27; 4-60; 5-9
boring machine, 2-9
in positioning, 5-79
machine tool system, 6-34
milling machine, 4-142
of rolling mill, 6-64

O

Optimizing, controllers, 5-71
Order picking, 5-68
Orienting,
assembly components, 1-52
device, 1-154
Oscillating blade, parts selectors, 5-82
Oscillating box, parts selectors, 5-86
Ovens,
infrared, 2-92
plastic finishing, 3-14

P

Package conveying system, 5-60
Packaging, machines, 3-12
Packing, garment, problem, 3-51
Painting,
conduit, 3-69
systems, 4-57
Pallet unloading, 5-68; 6-14
Parts selectors, 5-82
manufacturers of, 5-82
Payoff calculations, 5-60
pH control, 1-152
Philosophy, automation, 1-9, 141; 2-52; 5-46
Physics, basic, 5-156
Pin-type parts selectors, 5-82
Placing, parts for assembly, 1-52
Pneumatic,
machine systems, 3-78, 146
motion control, 3-79; 5-92
Positioning,
device, 2-148
hydraulic, 6-69
magnetostrictive device for, 4-73
numerical control, 4-60
pneumatic, 3-78
rotary table, 5-79
Post-process gaging, 1-81
Powder metallurgy, 3-20
Presses, 5-74
automated, 5-89
control, 2-14; 3-75
extrusion, 2-19; 6-12
feed mechanism, 2-10
feeding, 5-89
feeding, problem, 5-142
transfer, 1-33
transfer devices, 2-93
wheel bolster, 5-43
Pressure, magnetic tape recording, 6-50
Process,
annealing furnace atmosphere, 4-81
control, 2-14; 5-71
copper coating of wire, 4-80
engineering, 5-74
extrusion, 6-12
instruments, 4-139
metal fabricating, 6-130
plastic molding, 3-12
powder metallurgy, 3-20; 5-10
Processor, film, 1-12
Product design, 5-74
Programming, 3-57; 5-24
numerically-controlled line, 6-34
rolling mill, 6-64
tractors, 4-81
Proportioning, 3-94
Proximity pickups, 2-69
Pulse width modulation recording, 2-72
Punched cards, 6-64
control of machining, 5-79
in data processing, 3-65; 6-10
in inspection, 4-20
Punched tapes, 2-14

Q

Quality control, 3-61; 5-144

R

Radiation gages, 1-78; 6-10
Radio tone system control, 6-10
Radioisotopes in industry, 6-10
Railroad traffic control, 6-9
Reader, E. G.
Handling Small Parts for Assembly, 1-52
Recorded data playback, 2-72
Recording physical functions, 6-50
Rectifier silicon controlled, 2-25; 5-10
Regas, S.
Radiation Gages Improve Bulk Material Level Control, 1-78
Relays,
control, 3-82
noise-operated, 1-20
protective, 2-161
Reliability of electronic controls, 2-150
Replacement, equipment, 5-60
Road machinery manufacture, 4-39
Roll forming, 5-74
Roller bearings assembly, 2-57
Rolling mills, 2-93
Rotary,
stepping switch application, 3-89
switch problem, 3-51
Rotating barrel parts selectors, 5-82

S

Safety devices, 2-14; 3-159
Schematic diagrams, how to read, 4-139
Scrap shear, 4-9
Screwdriving, 4-77; 5-16
Semiconductors, 4-148
Sensing,
linear speed, problem, 4-140
systems, 2-69; 4-139
table positioning, 5-79
Sequencing, pneumatic systems, 5-92
Servosystem, 1-152
Servo, auto guidance, 4-39
Servo valves, 2-63
Sifting, sonic, 5-27
Sign typewriter, 3-22
Signal conversion, transistor circuits, 2-84
Smith, E. W.
Plug-Ins Provide Versatile Machine Control, 3-82
Sorting,
electronic mail, 5-12
gaged parts, 1-81; 3-73
mixed parts, problem, 6-134
Souler, R. A.
Dimensional Controlling Systems, 1-81; 3-73
Speed, magnetic tape recording, 6-50
Spray painting, 3-69
Staley, J. A.
Integrating Standard Machines to Perform Special Jobs, 6-57
Stamping feed mechanism, 2-10
Standards, tubing color code, 6-4
Stepping switches, 3-89
Stewart, H. L.
Basic Pneumatics for Automation, 3-78; 5-92
Stiles, J. W.
Package Conveying System, 5-60
Storage systems, 4-50; 6-14
Storing, 5-68
Superfinishing control, 4-92
Supplemental unemployment benefits, 2-52
Suuronen, E.
Automation for Small-Lot Producers, 3-54
Switching transistor circuits, 2-84
Systems,
approach to automation, 3-54
hydraulic, 2-63; 4-82; 6-69
integrated machine tool, 4-50

T

Tape,
eraser, 6-16
magnetic recording, 6-50
Tape controlled,
machine tool system, 6-34
milling machine, 5-9
positioning machine motions, 4-60
punching machine, 3-57
testing machine, 3-63
Tax policy, 5-51
Telemetering, 1-14; 2-72; 5-91
Temperature control, 6-16
magnetic tape recording, 6-50
Testing,
brazed conductors, problem, 5-142
electrical, 2-35; 4-20
electronic equipment, 3-61
functional, 3-61
inspection, 3-61
steel wire, 2-14
vacuum tubes, 6-19
Thermocouples, testing of, 4-139
Timing percentage, 3-159
Tool,
drilling, 3-22
thread top, 3-24
Torn, L.
Applying Magnetostrictive Actuation, 4-73
Transducers, 3-14
air to electric, 3-30
proximity, 2-69
Transfer devices, 1-63; 2-93; 3-159; 5-19, 88
Transfer machines,
assembly operations, 4-12, 50
numerically controlled, 6-34
Transistors, 1-152; 4-148
application, 2-84
power, 5-10
Translation, technical publications, 3-10
Treer, K. R.
Feeding Discrete Parts, 5-82
Trucks, industrial, 3-156

V

Valves,
control, 2-30
pneumatic, 3-146
servo, 2-63; 5-14
Van Nice, R. I.
Optimizing Process Operations, 5-71
Variable speed motors, 1-85
Vibration, magnetic tape recording, 6-50
Vibratory feeders, 5-82

W

Walker, J. R.
Applying Transistors, 2-84
Warehousing, 5-68
Webb, J. C.
Automatically Handling Parts In Process, 1-63
Weber, W. C.
Hydraulic Actuation Simplified, 3-86
Weighing, 1-12, 14; 5-76
continuous, 5-14
control, 3-94
crane problem, 4-140
paper rolls, 6-49
Welding, 1-9; 5-14, 74
control of, 2-69
production line, 6-68
Worthman, L. H.
Guideposts to Automation Planning, 2-52

X

X-ray inspection, 6-10

Z

Zawaski, F.
Auxiliary Handling Devices Integrate Standard Machines, 1-59

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AUTOMATION

problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1493-P
Sorting Mixed Parts

. . . We have a problem of segregating irregularly shaped parts. These parts are "findings," some of which differ only in the size of a hole, the length of an integral rivet or the size of a fillet. In all instances there is some minor variation in the total mass of metal. All parts are stampings, and most of them would not be flat but would have some irregular contour in common. Thickness of metal would range from 0.016 to 0.032 inch; over-all dimensions would range from ¼ to 1 inch by about ¼ inch. The sorting rate should be a minimum of 40 to 60 per minute and be hopper fed if possible. The parts are made of brass, steel, and combinations of brass and steel. . .

Staff Industrial Engineer

♦ ♦ ♦

Case 1510-P
Assembly of Darts

. . . We are one of the largest manufacturers of dart games in the country and are interested in automating the assembly of suction cups to plastic dart stems. We would appreciate it greatly if you would forward names of automatic machine manufacturers who would be interested in designing and manufacturing a machine to have the following specifications: Completely automatic. Prior to assembly of the suction cup to the stem, the rubber suction cup shall be squirted with toluene inside the cavity in which the stem is inserted. Amount of coverage with toluene is not critical as long as some area is moistened. You can assume a tolerance of plus or minus 0.005 inch on the parts. Twenty assemblies per minute minimum production rate. Two per cent maximum improper assemblies. Five per cent minimum downtime. Parts shall be fed from proper assemblies. Five per cent maximinimum. A counter shall indicate number of parts assembled. . .

Methods Engineer

Suggestions for 1325-P (Nov. 1957)
Feeding Thin Materials

. . . We have specialized in the development of machinery and devices for the soft goods industries. In our work we have had to design various types of feeding, registering, and stacking devices for extremely flexible and thin goods. We shall be pleased to have your reader submit his problem to us. . .

Benjamin Feldman
Automation Associates Inc.

♦

. . . Our organization has had considerable experience with such applications. If the person desiring help will communicate with us we shall be pleased to co-operate in reaching a solution. . .

S. S. Aidlin
Aidlings Inc.

♦ ♦ ♦

Suggestions for 1366-P (Jan. 1958)
Molding Wax Tires

. . . It's a pleasure to enclose Sales Manuals B59a and B48a, which will give you condensed information on our line of molded electrical goods and equipment. If you will forward additional information and possibly a sample as pointed out in your article, we are sure we will have an answer to your problem. . .

V. H. Lorenz
Joy Mfg. Co.

♦

. . . We note that our compound is used by the individual describing the requirement, and we have a development which we believe will satisfy the customer. . .

C. A. Herbst
BIWAX Corp.

♦ ♦ ♦

Suggestions for 1415-P (Mar. 1958)
Circuit Board Machines

. . . Although we do not make the machinery described by the inquirer, we have built handling equipment associated with the process and enclose several bulletins for his reference showing the handling of printed circuit boards. . .

A. Kornylak
M-H Standard Corp.

♦

. . . Our company has done quite a bit of development work in solving printed circuit board problems, and we have a number of machines in use. We believe the enclosed reprint will be of interest to your reader, and we ask you to forward it to him as this information may be helpful. . .

J. I. Kaul
Vapor Blast Mfg. Co.

Advertising Index

Adel Precision Products, A Division of General Metal Corporation 113
Allis, Louis, Co., The 85
Alvey Conveyor Manufacturing Co. 24
American Blower Division, American-Standard 105
American Can Co. 77
American Chain & Cable, Automotive & Aircraft Division 120
American MonoRail Co. 136
Apex Machine & Tool Co., The 82
Aurora Equipment Co., Equipto Division 129
Automation Devices, Inc. 123
Automotive & Aircraft Division, American Chain & Cable 120

Baker Brothers, Inc. 30
Baldor Electric Co. 22
Bellows Co., The 31
Bin-Dicator Co., The 129
Bliss, E. W., Co. 29

Carter Controls, Inc. 99
Chainveyor Corporation 8
Chicago Tramrail Corporation 118
Clark Controller Co., The 2
Cleveland Tramrail Division, The Cleveland Crane & Engineering Co. 111
Clippard Instrument Laboratory, Inc. 125
Control, A Division of Magnetics, Inc. 83
Counter & Control Corporation 125
Curtis Development & Mfg. Co. 127

Detroit Power Screwdriver Co. 95
Dixon Automatic Tool, Inc. 90
Dukes Co., Inc. 13
Dynamic Division, Eaton Manufacturing Co. 11

Eaton Manufacturing Co., Dynamic Division 11
Equipto Division of Aurora Equipment Co. 129

Farval Corporation, The 15
Federal Press Co. 88
Ferguson, J. L., Co. 103
Flick-Reedy Corporation, Miller Fluid Power Division 89
Fort Wayne Tool, Die & Engineering Co. 127

General Electric Co. 17
General Metals Corporation, Adel Precision Products Division 113
General Motors Corporation, Saginaw Steering Gear Division 27
Greenlee Bros. & Co. 109

Haberstump-Herrls, Inc. 120
Hannifin Co. 1
Hause Machines, Inc. 124
Horsburgh & Scott Co., The 114
Hunt, C. B., & Son, Inc. 84

Kearney & Trecker 87

Lansing Stamping Co. 127
Le Marie Machine & Tool Co. Back Cover
Lincoln Engineering Co., Division of The McNeil Machine & Engineering Co. 32
Lipe-Rollway Corporation 110
Lovejoy Flexible Coupling Co. 94

McKay Machine Co., The Inside Back Cover
McNeil Machine & Engineering Co., The, Lincoln Engineering Co. Division 32

Magnetics, Inc., Control Division 83
Magni-Power Co. 131
May-Fran Engineering, Inc. 128
Michigan Drill Head Co. 100
Miller Fluid Power Division of Flick-Reedy Corporation 89
Moline Tool Co. 96

National Acme Co., The 6, 7, 81
National Electric Welding Machines Co. 18

Ortman-Miller Machine Co. 5

Peerless Electric Co., The, Electric Motor Division 130
Pneu-trol Devices, Inc. 122
Post Electronics Division of Post Machinery Co. 112
Post Machinery Co., Post Electronics Division 112
Potter & Brumfield, Inc. 119

Reeves Pulley Co., Division of Reliance Electric & Engineering Co. 97
Reliance Electric & Engineering Co., Reeves Pulley Co. Division 97
Richards-Wilcox Manufacturing Co., Materials Handling Division 115

Saginaw Steering Gear Division of General Motors Corporation 27
Sandvik Steel, Inc., Steel Belt Conveyor Department 116
Sensory, Inc. 131
Snyder Tool & Engineering Co. Inside Front Cover
Special Engineering Service, Inc. 131
Standard Instrument Corporation 129
Swanson-Erie Corporation 78

Thomas Truck & Caster Co. 91
Tomkins-Johnson Co., The 23
True-Trace Sales Corporation 117

United States Drill Head Co. 126

WLS Stamping Co. 131
Warrick, Charles F., Co. 129
Westinghouse Air Brake Co., Industrial Products Division 107
Westinghouse Electric Corporation 20, 21, 92, 93
Wiley, John, & Sons, Inc. 98

Yoder Co., The 19

Consulting Engineer's Service 134

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Electric-Weld Tube

Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio—64 page handbook—The use of tube mills in the manufacture of pipe and tube is explained. A step-by-step description of the electric-weld process from roll forming and shaping of the tube to the finished product is given. Construction of the tube forming machine, the tube welder, and the sizing and straightening machine is noted. Photographs, drawings, and charts illustrate the operation, capacity, and application of various sized electric-weld tube mills.

Circle 471 on Page 139

Track-Guided Machine

National Cylinder Gas Co., 840 N. Michigan Ave., Chicago 11, Ill.—6 page pamphlet — A portable, electric motor-driven, track-guided machine suitable for automatic welding, cutting, and heat treating is described in Bulletin N-141. Data such as weights and travel speed ranges are given, and recommended accessories for welding, cutting, and flame heat-treating operations are also mentioned.

Circle 472 on Page 139

Assembly Units

Cleco Air Tools, Div., Reed Roller Bit Co., 5125 Clinton Dr., Houston 20, Tex. —16 page booklet—Line of multiple-spindle units for assembly lines is covered in Bulletin MS-358. Applications, features, and specifications are noted. Typical tools formed with the units are described and illustrated.

Circle 473 on Page 139

Packaging Machines

Gisholt Machine Co., Madison 10, Wis. —10 page bulletin—Machines which can apply cellulose neck bands to bottle goods are described in Bulletin 1210. The units are capable of handling all types of glass from vials to gallon jugs. Illustrations show the operating sequence, and drawings display both single and double discharge arrangements. Also discussed is a bottle spotter, which automatically positions bottles for operations such as the application of state tax stamps.

Circle 474 on Page 139

Switching Reactors

Control, Div., Magnetics Inc., Butler, Pa.—16 page booklet—Line of switching reactors for one-step static control is covered in Catalog S-10. The 10,000 to 1 switching ratio of each unit is explained and tables of electrical characteristics listed. Diagrams showing typical circuits for an alarm system, a press control system, and load switching system are given.

Circle 475 on Page 139

Latch Relays

Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio—4 page pamphlet —Bulletin 7305-PML covers mechanically-held latched-in relays. Nine models with from two to 10 poles are illustrated. The numbers of circuits and combinations of normally-open and normally-closed contacts available in stocked models are tabulated in chart form.

Circle 476 on Page 139

Fluid Power Controls

Carter Controls Inc., 2800 Bernice Rd., Lansing, Ill.—56 page catalog—Clamp type cylinders, air cylinders, hydraulic cylinders, air valves, piston rods, and rotary actuators are described and illustrated. Performance features are noted, and charts list specifications, prices, and other data. A force and capacity chart is also included.

Circle 477 on Page 139

Pressure Regulators

Kieley & Mueller Inc., 64 Genung St., Middletown, N. Y.—28 page handbook—Bulletin 401 describes back-pressure and relief valves of spring-loaded and weight-loaded types; reducing valves; remote pilot-type and valve-mounted regulators; steam operated, packless, and differential regulators. Data on how to select the proper pressure regulator are given. Graphic tables illustrate and compare the basic regulator characteristics.

Circle 478 on Page 139

Vibrating Feeders

Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio—4 page pamphlet—Data on eight different air-operated vibrating feeders, in lengths from 24 inches to 15 feet, are given in Bulletin 1000. Illustrations of the units and the applications they are designed for are noted.

Circle 479 on Page 139

High Strength Steels

Climax Molybdenum Co., 500 Fifth Ave., New York 36, N. Y.—16 page booklet — High-strength steels used for the manufacture of heavy machinery operating at high stresses, materials-handling equipment such as cranes, or portable tools, are discussed. A summary sheet for ultra-strength steels is given. Design and processing factors are explained. Composition and general data on steels produced by various companies are listed.

Circle 480 on Page 139

Motor Data

Fairbanks, Morse & Co., Fairbanks-Morse Bldg., Chicago 5, Ill.—3 bulletins—Construction of frames, bearings, conduit boxes, rotors, and stators of totally enclosed, fan cooled motors is explained in Bulletin 1205. Application, dimensions, frame sizes, and design features of totally enclosed explosion proof motors are covered in Bulletin 1200. Squirrel cage drip-proof induction motors are the subject of Bulletin 1150. Motor characteristics and advantages are noted.

Circle 481 on Page 139

Blast Cleaning

Wheelabrator Corp., 501 S. Byrkit St., Mishawaka, Ind.—32 page handbook—Machines which use controlled centrifugal force instead of compressed air for abrasive blasting are discussed in Catalog 951-D. The automatic and continuous cleaning production operation is explained. Also described in catalog are dust and fume control units, sandcutters, and core rod straighteners.

Circle 482 on Page 139

Phase-Shifting Transducers

Nilsen Mfg. Co., Addison, Ill.—30 page handbook—Data on the phase—shifter design and its applications are given in Section I of booklet. The theory of phase-shifter operation is discussed and a summary of sources of errors in phase-shifters and networks is given. Section II of booklet consists of procurement drawings showing dimensions of each phase-shifter and their performance specifications.

Circle 483 on Page 139

Water Treatment

Fischer & Porter Co., 540 Jacksonville Rd., Hatboro, Pa.—5 page pamphlet—Bulletin 90-130-25 shows how instrumentation of water and waste treatment in pulp and paper mills can improve efficiency, reduce manpower requirements, and save raw materials. A diagram of a system of instrumentation for pneumatic operation and control of rapid sand filters, and a diagram showing a layout of a typical water purification plant are included.

Circle 484 on Page 139

new catalogs..... latest literature

Hydraulic Pumps & Fluid Motors

Tuthill Pump Co., Dept. PR, 939 East 95th St., Chicago 19, Ill.—10 page bulletin—Oil hydraulic pumps with capacities from 1.2 to 14.2 gpm, for continuous service pressure to 1500 psi, and speeds to 3600 rpm; and spur gear hydraulic motors for continuous pressures to 1500 psi are described in Catalog 111. Data on pump-motor combinations, duplex or tandem models, and geared flow dividers are given. Also included are installation drawings and performance curves for various models.

Circle 485 on Page 139

Cartridge Heating Unit

Watlow Electric Mfg. Co., 1376 Ferguson Ave., St. Louis 14, Mo. — 6 page pamphlet—Cartridge heating unit with high watts density is described in Bulletin 365. A graph showing maximum watts per sq inch is listed, and notes on how to use the graph and how to determine watts density are given. Ordering instructions and prices are also mentioned.

Circle 486 on Page 139

Relays

Phillips Control Corp., Joliet, Ill.—2 bulletins—Multicontact relays for controlling a large number of circuits and sub-miniature relays for steady operation under severe conditions are described. Features and technical data are listed. Also included are dimensional drawings for both enclosed and hermetically sealed relays.

Circle 487 on Page 139

Indexing Chassis

Benerson Corp. 1319 W. Florida St., Station A, Box 127, Evansville, Ind.—4 page pamphlet—Unit designated Automator is subject of pamphlet. It can be equipped with the necessary tooling to perform multiple assembly and machining operations on high volume standardized products. Built-in features and alternative features are noted. Drawings of the drive section are also included.

Circle 488 on Page 139

Galvanometers

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.—12 page booklet — Galvanometers which can be used for testing industrial, or power-generating equipment during actual operating conditions, and measuring the amplitude and duration of minute signals from velocity, displacement, and pressure recording devices, are described in Bulletin 1528A. Principle of operation, construction features, and characteristics are explained. Data on selecting the proper galvanometer are given.

Circle 489 on Page 139

Worm Gear Jacks

Duff-Norton Co., P. O. Box 1889, Pittsburgh 30, Pa.—8 page bulletin—Worm gear jacks which provide precise control for lifting and lowering loads, applying pressure and resisting impact, are described in bulletin. Schematic drawings of gear jack components are given. Illustrative examples of various applications are also included.

Circle 490 on Page 139

Furnace Control

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.—2 bulletins—Control system which can be used with magnetic amplifiers and saturable core reactors is described. The system will continuously regulate power input to a variety of electric furnaces, either continuous or batch type. The individual components which can be supplied separately or in a complete package are mentioned and their specifications listed.

Circle 491 on Page 139

Selective Speed Drives

Century Electric Co., 18th & Pine Sts., St. Louis 3, Mo.—8 page bulletin—Motor speed control from alternating current is described in Bulletin 11-1, P1. The selective speed drive is explained and advantages noted. Illustrative examples of various applications are given.

Circle 492 on Page 139

Centralized Control

Kirkhof Electric Co., 2450 Buchanan Ave. S.W., Grand Rapids, Mich.—4 page pamphlet — Numerous types of control panels designed for specific applications are described and illustrated. Company's facilities for planning and constructing these units are discussed.

Circle 493 on Page 139

Aluminum Plug-in Busway

Distribution Assemblies Dept., General Electric Co., Plainville, Conn.—24 page handbook—Plug-in busways with aluminum conductors, designed for indoor use are described in Bulletin GEA-6173. Construction features, technical data and applications are given. A diagram shows a typical installation. Also noted and illustrated are numerous types of fittings which can be adapted to any contour.

Circle 494 on Page 139

Punch Press Accessories

Jaco Devices Inc., 102 High St., Hingham, Mass.—6 page pamphlet—Roll feeds, cam operated feeds, light-duty oiler-straightener, and heavy duty scrap choppers for punch press automation are described and illustrated. Operating principle, dimensions, capacities, and prices are noted.

Circle 495 on Page 139

Rotary Converters

Electronic Component Sales, Sangamo Electric Co., Springfield, Ill.—8 page bulletin—Data on line of rotary converters are contained in Bulletin 2541. Construction features of the armatures, bearings, field coils, commutators, and frame are mentioned. Also included are wiring diagrams and rotary converter ratings.

Circle 496 on Page 139

Cam Follower Bearings

Bearing Div., McGill Mfg. Co. Inc., Valparaiso, Ind.—4 page pamphlet—Cutaway photo of a cam follower displays features and advantages of the unit; construction of the device is also explained. Notes and illustrations of company's production methods are also given.

Circle 497 on Page 139

Welding Machines

National Electric Welding Machines Co., 1846 Trumbull St., Bay City, Mich.—6 page pamphlet—Integral combination spot and projection welder, air-operated press welder, hydraulically-operated flash welder, and a three-head air-operated projection welder are among units described and illustrated in Vol. 11, No. 3 of company publication. Features and production rates of the units are noted.

Circle 498 on Page 139

Permanent Magnets

Indiana Steel Products Co., Valparaiso, Ind.—12 page booklet—Permanent magnets and their uses in automatic machinery, electronic products and instrumentation devices are explained in Catalog PR-19. Charts listing specifications, and illustrations of the various shapes are given. Also described are magnetizers and demagnetizers.

Circle 499 on Page 139

Miniature Tube Shields

Staver Co. Inc., 41-51 N. Saxon Ave., Bay Shore, N. Y.—6 page pamphlet—Tube shielding and tube guard products for miniature and subminiature electron tubes are reviewed in Bulletin 100. Notes and drawings of six basic styles are included. Specifications, features and advantages are also mentioned.

Circle 500 on Page 139

Feed Processing Plants

Sprout, Waldron & Co. Inc., 130 Logan St., Muncy, Pa.—4 page pamphlet—Data on a 30-ton per hour broiler feed mill and a 45-ton per hour egg laying feed mill are contained in Bulletin 181. Design, engineering, and construction of the

plants are explained. Flow diagrams display the layout of the two plants. Company's facilities for planning and designing are outlined.

Circle 501 on Page 139

Tachometers

Jones Motrola Corp., P. O. Box 825, Stamford, Conn.—12 *page booklet*—Data on speed indicators for conveyors, compressors, generators, pumping equipment, and paper corrugators are contained in Booklet 58. The types of units described include machine tachometers, hand tachometers, surface speed indicators, and speed monitors. Drawings show different methods of installations.

Circle 502 on Page 139

Centrifugal Fans

General Blower Co., Morton Grove, Ill.—36 *page catalog*—Line of backward-blade fans, designed for use in heating-ventilating and air conditioning systems and industrial processes, is covered in Bulletin BB-105. Engineering data, specifications, and performance tables are given. Illustrations and drawings show the various arrangements of the fans.

Circle 503 on Page 139

Rotameters

Brooks Rotameter Co., P. O. Box 432, Lansdale, Pa.—8 *page bulletin*—Rotameters designed for pressure up to 5000 psi and for flow rate equivalents up to 3000 gpm of water are described in Bulletin 130. Diagrams show the indicating extension and interchangeable elements. A guide to the selection of transmitting and point-of-measurement extensions for rotameters is included.

Circle 504 on Page 139

Infrared Analyzers

Beckman Process Instruments Div., Beckman Instruments Inc., Fullerton, Calif.—6 *page bulletin*—Bulletin IR-4005 describes two infrared analyzers, which are applicable in the chemical, petroleum, and petrochemical industries. Model 15-A is suitable for continuous laboratory and pilot plant analysis, and Model 21 is used for continuous stream analysis. Photos of instruments and accessories are given.

Circle 505 on Page 139

Control Enclosures

Hoffman Engineering Corp., Anoka, Minn.—16 *page booklet*—Features, specifications, and applications for control panel enclosures, electrical wiring boxes, pushbutton enclosures, and weatherproof power outlets are given.

Circle 506 on Page 139

Ultrasonic Testing

Sperry Products Inc., Shelter Rock Rd., Danbury, Conn.—12 *page booklet*—Applications of ultrasonic inspection methods and equipment for quality control, production testing, and preventive maintenance

INDEX OF EQUIPMENT BY ITEM NUMBERS

(New Equipment, New Components, and New Literature covered in this issue)

Actuators, rotary, 477
Air tools, 473
Alarm, temperature, 437
Amplifier, transistor, 470
Analyzers
  gas, 413
  infrared, 505
Assembly
  air tools, 473
  terminal, 410
  unit, 406

Ball bearings, precision, 522
Batch weigher, 426
Bearings, cam follower, 497
Blending system, dry, 525
Boring machine, 416
Broaching machine, horizontal, 418
Bulk material, blending, 525
Bulk storage system, 427
Busway, aluminum plug-in, 494

Cam follower bearings, 497
Cam making machines, 515
Chemical processing, 408
Cleaner, for castings, 430
Cleaning, blast, 482
Clutch, air, 513
Coils, 506
Coil feed, pneumatic, 445
Coining, hammer, 428
Computer, digital, 524
Contactor, magnetic, 463
Control enclosures, 506
Controls, 493
  fluid power, 477
  furnace, 491
  numerical positioning, 425
  overload, 442, 444
  power, 408
  temperature, 466
  thermocouple, 434
Converters
  frequency, 443
  rotary, 496
Coolant system, 482
Counter, printing, 447
Crane hook switch, 442
Crimping, hammer, 428
Cutting machine, 472
Cylinders, 477
  heat resistant, 461

Data handling, frequency converter, 443
Data processing, 422, 429
  digital computer, 524
  tape transport, 457
Dehydration units, 509
Delay lines, 514
Diecasting machine, 414
Digital computer, 524
Diode classifier, 409
Diodes, silicon, 467
Drilling machine, gun, 415
Drives
  air clutch, 513
  hollow shaft reducer, 456
  motor pulley, 438
  variable speed, 492
  variable speed eddy current, 432
  v-belt, 520
Drop hammer, 423

Electrical components, 433, 434, 442, 456, 462, 475, 476, 481, 487, 496, 506, 508, 510, 514, 521
Enclosures, electrical, 506
Encoder, position, 454

Facing machine, 416
Fans, centrifugal, 503
Feed processing plants, 501
Feeders, 401
  coil, 445
  vibrating, 479
Flow meters, 504
  magnetic, 450
Forming drop hammer, 423
Furnace control, 491

Galvanometers, 489
Generator, function, 455
Grinding machines, cam, 515

Hammers
  air, 428
  drop forming, 423
Handling
  case stacker, 419
  magnetic rolls, 401
  orienting, 430
  overhead arm unloader, 420
  storage unit, 427
  tape transport, 457
  transfer machine, 403
  vibrating feeders, 479
Heat treating machine, 472
Heating cartridge, 486
Hose ends, 468
Hydraulic components, 439, 451, 453, 458, 460, 461, 464, 477, 485

Indexing, 405
  chassis, 488
  table, 412, 417
Indicators
  position, 449
  speed, 502
Infrared analyzers, 505
Insert, threaded, 459
Instrument controls, 444, 447, 448, 505, 519
Instrument indicators, 438, 449
Instrumentation, 484
  gas analyzer, 413

Jacks, worm gear, 490

Lathe, 402
Limit stop, 452
Limit switch, 433

Machine base, indexing chassis, 488
Machines
  armature winder, 431
  batch weighing, 426
  castings cleaner, 430
  cleaning, 482
  diecasting, 414
  hydraulic press, 408
  packaging, 474
  painting, 421
  tube mills, 471
  turning, facing, boring, 416
  weighing, 404, 411, 424
  welding, 405, 410, 498
  welding, cutting, heat-treating, 472
Machine tools
  broaching, 418
  cam making, 515
  drop hammer, 423
  gun drilling machine, 415
  lathe, 402
  milling, 517
  precision spindles, 518
  press accessories, 495
  transfer machine, 403, 523
Machine tool attachments
  coil feed, 445
  press unloader, 420
Magnets, permanent, 499
Marking, numbering head, 436
Measuring
  galvanometers, 489
  magnetic flow meter, 450
  pneumatic transmitter, 519
  pressure transducer, 464
  rotameters, 504
  temperature alarm, 437
  temperature control, 466
  thermocouple, 434
Meters
  flow, 504
  magnetic flow, 450
Milling machines
  cam, 515
  contour, 517
Motor pulley, 438
Motors
  electric, 481
  fluid, 485
  rotary air, 446
Numbering head, 436
Numerical display, 435
Numerical positioner, 425

Orienting equipment, 430
Overload control, 442, 444
Packaging
  machines, 474
  weighing machine, 404, 411, 424
Painting machine, 421
Pneumatic components, 439, 446, 451, 453, 458, 461, 464, 465, 468, 469, 477, 478
Position encoder, 454
Positioner, numerical, 425
Power center, 441
Power controller, 408
Press accessories, 495
Presses
  coil feed for, 445
  hydraulic, 466
  printed circuit, 497
  unloader for, 420
Printed circuit press, 497
Printing counter, 447
Production control system, 516
Programming, generator, 455
Processing, gas analyzer, 413
Proximity transducer, 440
Pulley, motor, 438
Pumps, 460
  hydraulic, 485
Punch press accessories, 495
Punched tape reader, 423

Reactors, switching, 475
Readout, 435
Recorder, electronic, 448
Reducer, hollow shaft, 456
Regulators, pressure, 478
Relays, 487, 508
  latch, 476
Riveting, hammer, 428
Rotameters, 504

Solenoids, 506
  control valve, 453, 465
  valve, 439, 469
Spindles, precision, 518
Stacker, 401
  case, 419
Staking, hammer, 428
Steel, ultra strength, 480
Storage system, 427
Storage unit, data, 429
Switches
  air gap limit, 433
  crane hook, 442
  mercury, 521
  pressure, 458
Switching reactors, 475

Tachometers, 502
Tape controlled positioner, 425
Tape, punched reader, 423
Tape transport, 457
Temperature alarm, 437
Temperature control, 466, 491
Terminal assembler, 410
Testing
  diode classifier, 409
  galvanometers, 489
  ultrasonic, 507
Thermocouple, 434
Tool monitor, 444
Tracer, 402
Transducers
  phase-shifting, 453
  pressure, 464
  proximity, 440
Transfer machines, 403, 523
Transistor, amplifier, 470
Transmitter, pneumatic, 519
Tube mills, 471
Tube shields, miniature, 500
Tubes
  electronic, 510
  pneumatic system, 511
Turning machine, 416

Ultrasonic testing, 507
Unloader, overhead arm, 420

Vacuum valve, 469
Valves, 466, 477, 478
  control, 451
  solenoid, 439, 469
  solenoid control, 453
Variable speed drives, 432, 492
V-drives, 520

Water treatment, 484
Water treatment equipment, 512
Weighing machines, 404, 411, 424
  batch, 426
Welding machines, 405, 410, 472, 498
Winder, armature, 431

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409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
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414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
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422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
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425	465	505	545	585	625	665	705	745	785	825
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427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
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are described in Bulletin 50-107. The variety of raw materials suitable for testing are noted, inspection techniques and maintenance operations explained.

Circle 507 on Page 139

Relays

Comar Electric Co., 3349 *Addison St., Chicago* 18, *Ill.*—36 *page catalog*—Line of relays, coils, and solenoids is covered in Catalog 58. Data on general purpose ac, dc, plug-in, printed circuit, and telephone types are given. Standard and special coils, and laminated type and open frame solenoids are described. Diagrams of switch assemblies are also given.

Circle 508 on Page 139

Dehydration Unit

Dehydrators Inc., P. O. Box 7359, *Tulsa, Okla.* — 4 *page pamphlet* — Dissipating chemical type dehydrators for gas, air, or liquids are described. The glass fiber filter, compensating cartridge, water level gage and liquid flow capacity is explained, and general configurations given. Also included are illustrative examples of numerous applications.

Circle 509 on Page 139

Industrial/Special Tubes

Electronic Tube Div., Westinghouse Electric Corp., Dept. T-286, P. O. Box 284, *Elmira, N. Y.*—20 *page booklet*—Data on camera tubes and radiation detection tubes are contained in Bulletin 86-020A. Charts listing typical operating conditions and characteristics, and diagrams of clear tube sockets are given. Notes on proper maintenance are also mentioned.

Circle 510 on Page 139

Pneumatic Tube Systems

Standard Conveyor Co., North St. Paul 9, *Minn.*—12 *page booklet*—Data on line of vacuum, pressure, and semiautomatic pneumatic tubes are contained in Bulletin 12. Different types of carriers are illustrated and body dimensions noted. Photos of various applications are given.

Circle 511 on Page 139

Water Treatment Equipment

Permutit Co., 50 *W.* 44th *St., New York* 36, *N. Y.*—12 *page booklet*—Water impurities and methods of treatment of municipal, industrial, and boiler-feed water are outlined in Bulletin 4433. Typical treatment systems are illustrated and the operating principle and range of flow rates explained. Aerators, deaerators, precipitation equipment, filters, and ion exchange equipment are described.

Circle 512 on Page 139

Air Clutch

Fawick Airflex Div., Fawick Corp., 9919 *Clinton Rd., Cleveland* 11, *Ohio*—13 *page booklet*—Clutches designed for machines with small horsepower requirements are covered. Specifications and dimensions are listed, and diagrams of control systems given. Data on the selection of the proper size are noted. A price list is also included.

Circle 513 on Page 139

Delay Lines

Columbia Technical Corp. 61-02 31st *Ave., Woodside* 77, *N. Y.*—12 *page booklet*—Data on the proper use and installation of magnetic-core delay lines are contained in Bulletin 18. Mechanical and electrical terminations, and mounting and test procedures are explained. Drawings and oscillograms help illustrate the test procedure.

Circle 514 on Page 139

Cam Making Machines

Rowbottom Machine Co., Waterbury, Conn.—2 *bulletins*—Cam milling machines and cam grinding machines are described and illustrated and specifications listed. Photos display various attachments. Also illustrated are different types of cams produced by the company for industry. Company's facilities and service are discussed.

Circle 515 on Page 139

Production Control System

Control Systems Co., Div., Hancock Industries Inc., Jackson, Mich.—8 *page bulletin*—Production control system for recording manufacturing data is subject of brochure. The equipment which can automatically report the operator's productive and nonproductive time, count the pieces produced, and supply a running count of the remaining pieces on order is described.

Circle 516 on Page 139

Contour Milling Machines

Onsrud Machine Works Inc., 7720 *N. Lehigh Ave., Niles* 31, *Ill.*—8 *page bulletin*—Data on the contour machining of unsupported honeycomb cells and the tooling and fixture set-ups required for these operations are contained in Bulletin 1167. Milling machines are described and specifications, work area, and cutter speeds noted.

Circle 517 on Page 139

Precision Spindles

Ex-Cell-O Corp., 1200 *Oakman Blvd., Detroit* 32, *Mich.*—8 *page bulletin*—Data on line of spindles for precision grinding and boring operations are given. Numerous models are shown and applications noted. As replacement spindles the units can be used to improve the performance of grinders and boring machines already in use.

Circle 518 on Page 139

Pneumatic Transmitter

Bailey Meter Co., 1050 *Ivanhoe Rd., Cleveland* 10, *Ohio*—4 *page pamphlet*—Bulletin P22-4 contains data on an area meter pneumatic transmitter for flow measurement of water, gasoline, oil, tar, chemicals, and distillates. Drawings of external and mounting dimensions, a table of flow ranges, and installation requirements are noted.

Circle 519 on Page 139

V-Drives

Maurey Mfg. Corp., 2907-23 *S. Wabash Ave., Chicago* 16, *Ill.*—44 *page catalog*—Data on line of bushed type V-pulleys, fixed bore type V-pulleys, V-link belting, and fan V-pulleys, are contained in Bulletin F-10. Notes on selecting the proper V-belt drive for each application are given. Ways to determine the proper belt length and pulley size are discussed.

Circle 520 on Page 139

Mercury Switches

Gordos Corp., 250 *Glenwood Ave., Bloomfield, N. J.*—8 *page bulletin*—Mercury switches for applications involving current ranging from milliamps to 45 amperes are covered in booklet. Specifications are listed and drawings display the numerous switch arrangements possible.

Circle 521 on Page 139

Precision Ball Bearings

Barden Corp., Danbury, Conn.—6-*page pamphlet*—Line of precision miniature ball bearings with sizes from ⅝-inch OD and smaller, is covered in Catalog Supplement M1. Data on low torque bearings, wide inner ring bearings, and special purpose bearings are included. Load capacities, limiting speeds, and torque values are listed.

Circle 522 on Page 139

Production Machine Tools

Producto Machine Co., Bridgeport 1, *Conn.*—12 *page booklet*—Rotary transfer machines, line transfer machines, and special machines are described and illustrated. Operational sequence and production rates of the different units are given. Company's facilities for producing machinery are also mentioned.

Circle 523 on Page 139

Digital Computer

Bendix Computer, Div., Bendix Aviation Corp., 5630 *Arbor Vitae St., Los Angeles* 45, *Calif.*—6 *page pamphlet*—Model G-15, a general purpose digital computer, is discussed in Bulletin AB-116-R-018. Programming techniques are explained and numerous applications mentioned. Input and output accessories are also noted.

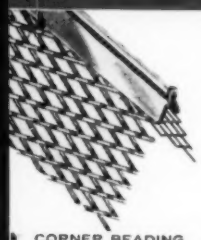
Circle 524 on Page 139

Dry Blending System

Fuller Co., Catasauqua, Pa.—16 *page booklet*—System for aeration blending of dry pulverized materials is explained in Bulletin B-2. The operating principle and installation method are described and functions of the various components noted. Illustrations and drawings display the results of quadrant blending and pulsated aeration. Diagrams show the blending tolerance of materials that differ in bulk density and fineness.

Circle 525 on Page 139

The Shapes of Things to Come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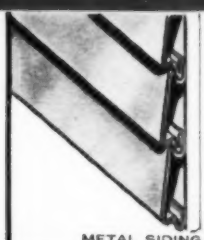
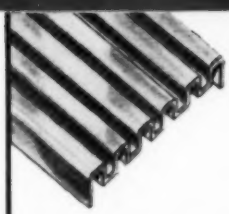
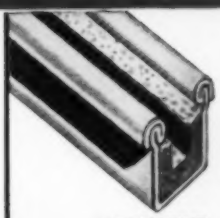
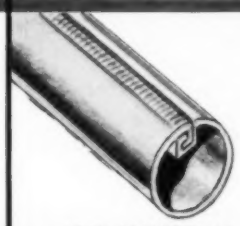

METAL SIDING

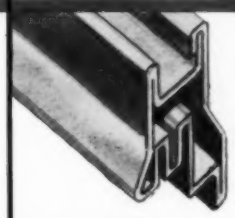

METAL DECK—FLUTING

STAINLESS—GALVANIZED TRIM

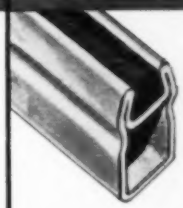

AUTOMOTIVE WEATHERSTRIP

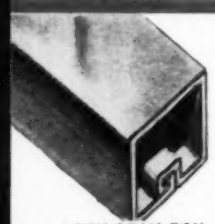
RACEWAYS

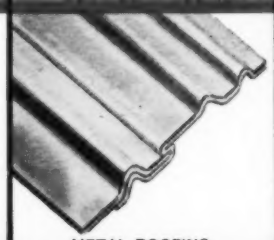

LOCK SEAM TUBING


WINDOW SECTIONS

MOULDING


NAILING FLANGES


LOCK SEAM BOX SECTIONS


METAL ROOFING

IRREGULAR PATTERNS

COATED METAL PRICE STRIPS

SHEET and STRIP FLANGING

Call for McKAY FORMING MACHINERY

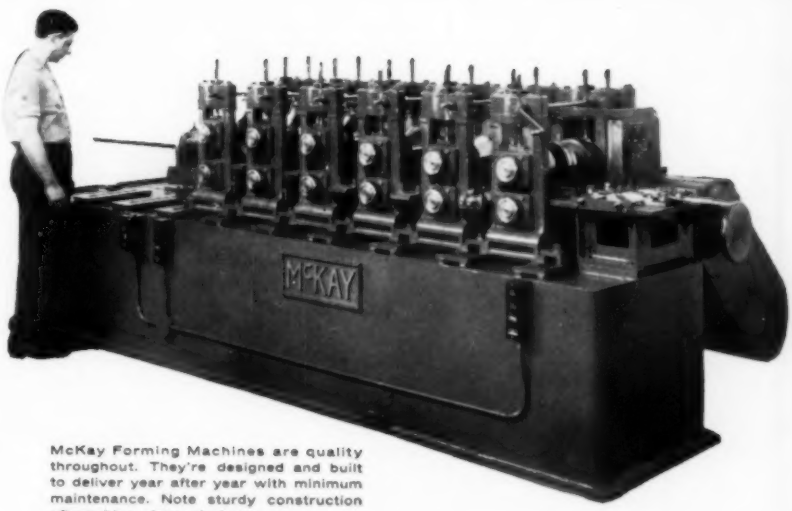
Two words that best describe McKay Forming Machines are "precision" and "ruggedness."

McKay Forming Machines are the last word in quality. They're designed and built to perform with extreme accuracy year after year. McKay users the world over know that quality is never sacrificed, even in the smallest details, for the sake of marketing a "cheaper" unit.

And McKay Forming Machines are built to customers' requirements with an eye to the future. They're machines that will not only meet today's needs, but machines that are ready for the faster speeds, tougher metals and more intricate shapes of tomorrow.

Be sure you have checked with McKay before you order forming equipment. You'll find this unmatched precision and ruggedness pays off in better forming at greatly reduced costs. And with a McKay—you're ready for tomorrow!

Circle 652 on Page 139



McKay Forming Machines are quality throughout. They're designed and built to deliver year after year with minimum maintenance. Note sturdy construction of machine pictured above.

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McK

ENGINEERS AND DESIGNERS OF EQUIPMENT FOR THE AUTOMOTIVE, FABRICATING AND STEEL INDUSTRIES

Truck Manifolds Completely Machined, Re-positioned 5 Times, in 55 Seconds

This 25-station LeMaire "Producer" completely machines three different styles of truck engine manifold castings. The machine is built for transfer-through operation and features automatic loading and clamping at each station. The part is re-positioned five times while in process during the 55-second machining cycle, including one 180 degree roll-over, one rotation for vibratory chip removal, indexing for a probing operation, one 90 degree index and re-index.

Features include: Unitized "building block" construction, with provision made for future changes—lighting at every work station—complete electrical interlock and individual selector switches and controls at each work station—"PresTest" lights on main control console—automatic selective lubrication of fixtures and ways—lights indicating "Automatic" or "Manual" control for safety during setups — electrical and hydraulic systems to J.I.C. — 189 hp electrical system—hardened and ground wear surfaces.

Here is another successful *producing* installation, designed, manufactured and tooled by LeMaire. Tell us about *your* next production machining problem.

Circle 653 on Page 139

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